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CONTENTS

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LIST OF MEETINGS AND PAST OFFICERS

First Annual Meeting, Washington, D. C., Nov. 12–14, 1889. President, C. V. Riley; Vice-President, S. A. Forbes; Second Vice-President, A. J. Cook; Secretary, John B. Smith.

Second Annual Meeting, Champaign, Ill., Nov. 11–13, 1890. (The same officers had charge of this meeting).

Third Annual Meeting, Washington, D. C., Aug. 15—18, 1891. President, James Fletcher; First Vice-President, F. H. Snow; Second Vice-President, Herbert Osborn; Secretary, L. O. Howard.

Fourth Annual Meeting, Rochester, N. Y., Aug. 15—16, 1892. President, J. A. Lintner; First Vice-President, S. A. Forbes; Second Vice-President, J. H. Comstock; Secretary, F. M. Webster.

Fifth Annual Meeting, Madison, Wis., Aug. 14—16, 1893. President, S. A. Forbes; First Vice-President, C. J. S. Bethune; Second Vice-President, John B. Smith; Secretary, H. Garman.

Sixth Annual Meeting, Brooklyn, N. Y., Aug. 14—15, 1894. President, L. O. Howard; First Vice-President, John B. Smith; Second Vice-President, F. L. Harvey; Secretary, C. P. Gillette.

Seventh Annual Meeting, Springfield, Mass., Aug. 27—28, 1895. President, John B. Smith; First Vice-President, C. H. Fernald; Secretary, C. L. Marlatt.

Eighth Annual Meeting, Buffalo, N. Y., Aug. 21—22, 1896. President, C. H. Fernald; First Vice-President, F. M. Webster; Second Vice-President, Herbert Osborn; Secretary, C. L. Marlatt.

Ninth Annual Meeting, Detroit, Mich., Aug. 12—13, 1897. President, F. M. Webster; First Vice-President, Herbert Osborn; Second Vice-President, Lawrence Bruner; Secretary, C. L. Marlatt.

Tenth Annual Meeting, Boston, Mass., Aug. 19—20, 1898. President Herbert Osborn; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, C. L. Marlatt.

Eleventh Annual Meeting, Columbus, Ohio, Aug. 18—19, 1899. President, C. L. Marlatt; First Vice-President, Lawrence Bruner; Second Vice-President, C. P. Gillette; Secretary, A. H. Kirkland.

Twelfth Annual Meeting, New York, N. Y., June 22—23, 1900. President, Lawrence Bruner; First Vice-President, C. P. Gillette; Second Vice-President, E. H. Forbush; Secretary, A. H. Kirkland.

Thirteenth Annual Meeting, Denver, Colo., Aug. 23—24, 1901. President, C. P. Gillette; First Vice-President, A. D. Hopkins; Second Vice-President, E. P. Felt; Secretary, A. L. Quaintance.

Fourteenth Annual Meeting, Pittsburgh, Pa., June 27—28, 1902. President, A. D. Hopkins; First Vice-President, E. P. Felt; Second Vice-President, T. D. A. Cockerell; Secretary, A. L. Quaintance.

Fifteenth Annual Meeting, Washington, D. C., Dec. 26—27, 1902. President, E. P. Felt; First Vice-President, W. H. Ashmead; Second Vice-President, Lawrence Bruner; Secretary, A. L. Quaintance.

Sixteenth Annual Meeting, St. Louis, Mo., Dec. 29—31, 1903. President, M. V. Slingerland; First Vice-President, C. M. Weed; Second Vice-President, Henry Skinner; Secretary, A. F. Burgess.

Seventeenth Annual Meeting, Philadelphia, Pa., Dec. 29—30, 1904. President, A. L. Quaintance; First Vice-President, A. F. Burgess; Second Vice-President, Mary E. Murtfeldt; Secretary, H. E. Summers.

Eighteenth Annual Meeting, New Orleans, La., Jan. 1—4, 1906. President, H.

Garman; First Vice-President, E. D. Sanderson; Second Vice-President, F. L. Washburn; Secretary, H. E. Summers.

Nineteenth Annual Meeting, New York, N. Y., Dec. 28—29, 1906. President, A. H. Kirkland; First Vice-President, W. E. Britton; Second Vice-President, H. A. Morgan; Secretary, A. F. Burgess.

Twentieth Annual Meeting, Chicago, Ill., Dec. 27—28, 1907. President, H. A. Morgan; First Vice-President, H. E. Summers; Second Vice-President, W. D. Hunter; Secretary, A. F. Burgess.

Twenty-first Annual Meeting, Baltimore, Md., Dec. 28—29, 1908. President, S. A. Forbes; First Vice-President, W. E. Britton; Second Vice-President, E. D. Ball; Secretary, A. F. Burgess.

Twenty-second Annual Meeting, Boston, Mass., Dec. 28—29, 1909. President, W. E. Britton; First Vice-President, E. D. Ball; Second Vice-President, H. E. Summers; Secretary, A. F. Burgess.

Twenty-third Annual Meeting, Minneapolis, Minn., Dec. 28—29, 1910. President, E. D. Sanderson; First Vice-President, H. T. Fernald; Second Vice-President, P. J. Parrott; Secretary, A. F. Burgess.

Twenty-fourth Annual Meeting, Washington, D.C. Dec. 27—29, 1911. President, F. L. Washburn; First Vice-President, E. D. Ball; Second Vice-President, R. H. Pettit; Secretary, A. F. Burgess.

Twenty-fifth Annual Meeting, Cleveland, Ohio, Jan. 1—3, 1913. President, W. D. Hunter; First Vice-President, T. J. Headlee; Second Vice-President, R. A. Cooley; Secretary, A. F. Burgess.

Twenty-sixth Annual Meeting, Atlanta, Ga., Dec. 31, 1913—Jan. 2, 1914. President, P. J. Parrott; First Vice-President, E. L. Worsham; Second Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Twenty-seventh Annual Meeting, Philadelpha, Pa., Dec. 28–31, 1914. President, H. T. Fernald; First Vice-President, Glenn W. Herrick; Second Vice-President, W. E. Britton; Third Vice-President, Wilmon Newell; Secretary, A. F. Burgess.

Special Meeting, Berkeley, Cal., Aug. 9—10, 1915. (Officers same as for Twenty-eighth Annual Meeting).

Twenty-eighth Annual Meeting, Columbus, Ohio, Dec. 27—30, 1915. President, Glenn W. Herrick; First Vice-President, R. A. Cooley; Second Vice-President W. E. Rumsey; Third Vice-President, E. F. Phillips; Secretary, A. F. Burgess.

Twenty-ninth Annual Meeting, New York, N. Y., Dec. 28—30, 1916. President, C. Gordon Hewitt; First Vice-President, G. A. Dean; Second Vice-President, E. D. Ball; Third Vice-President, W. J. Schoene; Fourth Vice-President, T. J. Headlee; Secretary, A. F. Burgess.

Thirtieth Annual Meeting, Pittsburgh, Pa., Dec. 31, 1917—Jan. 2, 1918. President, R. A. Cooley; First Vice-President, W. E. Hinds; Second Vice-President, A. W. Morrill; Third Vice-President, G. M. Bentley; Fourth Vice-President, B. N. Gates; Secretary, A. F. Burgess.

Thirty-first Annual Meeting, Baltimore, Md., Dec. 26—27, 1918. President, E. D. Ball; First Vice-President, W. C. O'Kane; Second Vice-President, G. P. Weldon; Third Vice-President, E. C. Cotton; Fourth Vice-President, Franklin Sherman, Jr.; Secretary, A. F. Burgess.

Thirty-second Annual Meeting, St. Lous, Mo., Dec. 31, 1919—Jan. 2, 1920. President, W. C. O'Kane; First Vice-President A. G. Ruggles; Second Vice-President,

H. J. Quayle; Third Vice-President, E. C. Cotton; Fourth Vice-President, W. E. Britton; Secretary, A. F. Burgess.

Thirty-third Annual Meeting, Chicago, Ill., Dec. 29—31, 1920. President, Wilmon Newell; First Vice-President, H. A. Gossard; Second Vice-President, E. M. Ehrhorn; Third Vice-President, J. G. Sanders; Fourth Vice-President, F. B. Paddock; Secretary, A. F. Burgess.

Thirty-fourth Annual Meeting, Toronto, Canada, Dec. 29—31, 1921. President, George A. Dean; First Vice-President, Arthur Gibson; Second Vice-President, E. O. Essig; Third Vice-President, A. G. Ruggles; Fourth Vice-President, H. F. Wilson; Secretary, A. F. Burgess.

Thirty-fifth Annual Meeting, Boston, Mass. Dec. 28—30, 1922. President, J. G. Sanders; First Vice-President, J. M. Swaine; Second Vice-President, A. L. Lovett; Third Vice-President, R. W. Harned; Fourth Vice-President, M. C. Tanquary; Secretary, A. F. Burgess.

Thirty-sixth Annual Meeting, Cincinnati, Ohio, Dec. 29, 1923—Jan 2. 1924. President, A. G. Ruggles; First Vice-President, H. A. Gossard; Second Vice-President, H. J. Quayle; Third Vice-President, P. A. Glenn; Fourth Vice-President, S. B. Fracker; Secretary, A. F. Burgess.

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606. Partridge, N. L., Michigan Agricultural College, E. Lansing, Mich.
607. Patch, L. H., 10 Court St., Arlington, Mass.
608. Patts, S. F., College Park, Md.
609. Peake, G. W., University Farm, St. Paul, Minn.
610. Pearson, G. B., Box 95, West Lafayette, Ind.
611. Penny, D. D., Watsonville, Calif.
612. Phillips, Saul, Conservation Commission, Albany, N. Y.
613. Phipps, Clarence R., Experiment Station, Mountain Grove, Mo.
614. Pinckney, J. S., 126 S. Minneapolis Ave., Wichita, Kansas.
615. Pollock, J. H., Box 423, Colorado Springs, Colo.
616. Powers, E. B., Univ. Tennessee, Knoxville, Tenn.
617. Price, W. A., Purdue University, Lafayette, Ind.
618. Primm, James K., Oak Lane, Pa.
619. Rea, George H., Reynoldsville, Pa.
620. Readio, Phillip A., Lawrence, Kan.
621. Reeher, Max M., Forest Grove, Ore.
622. Reese, C. A., Dept. Agriculture, Columbus, Ohio.
623. Remy, Theron P., 554 E. Gates St., Columbus, Ohio.
624. Reppert, R. R., College Station, Texas.
625. Ressler, I. L., Ames, Iowa.
626. Richardson, T. R., 10 Court St., Arlington, Mass.
627. Ries, Donald T., 401 Thurston Ave., Ithaca, N. Y.
628. Riley, George E., Agricultural College, Miss.
629. Robinson, C. L., Olympia, Wash.
630. Robinson, J. M., Experiment Station, Auburn, Ala.
631. Robinson, Wm., University of Kansas, Lawrence, Kans.
632. Rogers, D. M., U. S. Bureau of Entomology, 402 Atlantic Ave., Boston, Mass.
633. Rogers, Leslie, 496 E. Washington St., Bridgeport, Conn.

634. Rolfs, P. H., Viscosa E. F. Leopoldina, Minas Geraes, Brazil.
635. Root, E. R., Medina, Ohio.
636. Rosewall, O. W., State University, Baton Rouge, La.
637. Roullard, Fred P., 320 Holland Bldg., Fresno, Calif.
638. Rounds, M. B., 993 Pasadena Ave., Azusa, Calif.
639. Ruffin, W. A., 304 Russell St., Ames, Iowa.
640. Ryan, H. J., 907 Hall of Records, Los Angeles, Calif.
641. Sanders, P. D., College Park, Md.
642. Schaffner, J. V., Jr., Melrose Highlands, Mass.
643. Scott, W. M., 518 Oak Ave., Sanford, Fla.
644. Scullen, H. A., Agricultural College, Corvallis, Ore.
645. Searls, E. M., College of Agriculture, Madison, Wisc.
646. Sechrist, E. L., 423 Dorset Ave., Chevy Chase, Washington, D. C.
647. Shotwell, R. L., Box 1094, Billings, Mont.
648. Sibley, C. K., Roberts Hall, Ithaca, N. Y.
649. Simmons, Perez, Box 241, Silver Spring, Md.
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651. Smit, B., Roberts Hall, Ithaca, N. Y.
652. Smith, A. G., 152 S. Lake Ave., Pasadena, Calif.
653. Smith, Charles E., Experiment Station, Baton Rouge, La.
654. Smith, G. A., State Forester's Office, State House, Boston, Mass.
655. Smith, G. E., Albion, N. Y.
656. Smith, H. D., Kronenberg Building, Carlisle, Pa.
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658. Soliman, L. B., Department Entomology, University of California, Berkeley, Calif.
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664. Spencer, Herbert, Box 88, Norfolk, Va.
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669. Stiles, C. F., Box 37, Stillwater, Okla.
670. Stinson, Elton S., Agricultural Experiment Station, New Brunswick, N. J.
671. Stirling, Frank, State Plant Board, Gainesville, Fla.
672. Stirrett, Geo. M., Purdue University, Lafayette, Ind.
673. Stockwell, C. W., Entomological Laboratory, Riverton, N. J.
674. Strand, A. L., Agricultural Experiment Station, Bozeman, Mont.
675. Strong, Lee A., Federal Horticultural Board, Washington, D. C.
676. Sullivan, K. C., Agricultural Experiment Station, Columbia, Mo.
677. Sutton, F. J., Middleport, N. Y.
678. Sweetman, H. L., 317 Lynn Ave., Ames, Iowa.
679. Taft, L. R., East Lansing, Mich.
680. Talbert, T. J., Whitten Hall, Columbia, Mo.

681. Taylor, L. H., W. Va. University, Morgantown, W. Va.
682. Thomas, C. A., 120 S. Broad St., Kennett Sq., Chester Co., Pa.
683. Thomas, W. A., Chadbourn, N. C.
684. Thompson, B. G., 600 26th St., Sacramento, Calif.
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686. Tissot, A. N., 1902 N. High St., Columbus, Ohio.
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689. Tower, D. G., Room 305, Custom House, New York, N. Y.
690. Trimble, F. M., Camp Hill, Cumberland Co., Pa.
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702. Walter, E. V., Tempe, Ariz.
703. Warren, Don. C., Valdosta, Ga.
704. Weed, C. M., State Normal School, Lowell, Mass.
705. Wehrle, L. P., Roberts Hall, Ithaca, N. Y.
706. Wells, A. B., Bryn Athyn, Pa.
707. Wells, R. W., Box 208, Dallas, Texas.
708. West, L. S., Roberts Hall, Ithaca, N. Y.
709. Whelan, Don B., Dept. Entomology, Univ. Nebraska, Lincoln, Nebr.
710. Whitcomb, W. D., Box 5171 Station B, New Orleans, La.
711. Whitmarsh, R. D., Madison Ave., Wooster, Ohio.
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713. Williamson, Warren, R. D. 5, Galesburg, Ill.
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716. Woodworth, H. E., 2237 Carlton St., Berkeley, Calif.
717. Wooldridge, Reginald, U. S. Bureau of Entomology, Melrose Highlands, Mass.
718. Worsinger, F. H., Box 6212, Holmsburg, Philadelphia, Pa.
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720. Wymore, Floyd H., 2233½ McKinley St., Berkeley, Calif.
721. Young, A. W., South Yarmouth, Mass.
722. Young, H. C., Florence, S. C.
723. Young, M. T., Tallulah, La.
724. Yuasa, Hachiro, Institute of Entomology, Kyoto Imperial Univ., Kyoto, Japan.

FOREIGN MEMBERS

Anderson, T. G., Nairobi, British East Africa.
Ballou, H. A., West Indian Agricultural College, St. Augustine, Trinidad, West Indies.
Berlese, Dr. Antonio, Reale Stazione di Entomologia, Agraria, Firenze, Italy.
Bordage, Edmond, Directeur de Musee, St. Denis, Reunion.
Brain, Charles K., Pretoria, South Africa.
Carpenter, Dr. George H., Royal College of Science, Dublin, Ireland.
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Danysz, J., Laboratoire de Parasitologie, Bourse de Commerce, Paris, France.
DeBussy, L. P., Deli, Sumatra.
Escherisch, K., Forstliche Versuchsaustalt, Universitat, Munich, Germany.
French, Charles, Department of Agriculture, Melbourne, Australia.
Froggatt, W. W., 12 Young St., Croyden, Sydney, New South Wales.
Fuller, Claude, Department of Agriculture, Peitermaritzburg, Natal, South Africa.
Goding, F. W., Guayaquil, Ecuador, South America.
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Green, E. E., Way's End, Beach Ave., Camberley, Surry, England.
Herrera, A. L., Directòr de Estudios, Bibliogicas, Secretaria de Agricultura y Formento, Mexico, D. F. Mexico.
Hill, Gerald F., 5 Clifton Rd., Hawthorn, Melbourne, Australia.
Horvath, Dr. G., Musee Nationale Hongroise, Budapest, Hungary.
Jablonowski, Josef, Entomological Station, Budapest, Hungary.
Jack, Rupert W., Salisbury, Rhodesia, South Africa.
Johnson, Thomas H., University of Brisbane, Queensland, Australia.
Kulagin, Nikolai M., Petrovsky-Rasumovsky Academy, Petrovsko-Rasumovskoie, Moscow, Russia.
Kuwana, S. I., Imperial Agricultural Experiment Station, Yokohama, Japan.
Lea, A. M., National Museum, Adelaide, South Australia.
Lounsbury, Charles P., Department of Agriculture, Pretoria, Transvaal, South Africa.
Mally, C. W., Department of Agriculture, Cape Town, South Africa.
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Mokshetsky, Sigismond, Warsaw University, Warsaw, Poland.
Mussem, Charles T., Hawkesbury Agricultural College, Richmond, New South Wales.
Nawa, Yashushi, Entomological Laboratory, Kyomachi, Gifu, Japan.
Newstead, Robert, University of School Tropical Medicine, Liverpool, England.
Porter, Carlos E., Casilla 2352, Santiago, Chili.
Pospielow, Dr. Waldemar, Bureau of Entomology, Morskaya 44, Petrograd, Russia.
Reed, Charles S., Mendoza, Argentine Republic, South America.
Ritzema Bos, Dr. J., Wageningen, Holland.
Rosenfeld, A. H., Ingenio Santa Ana, F. C. N. O. A., Tucuman, Argentina.
Sajo, Prof. Karl, Godollo-Veresegyhaz, Hungary.
Schoyen, Prof. W. M., Zoological Museum, Christiania, Norway.
Severin, Prof. G., Curator Natural History Museum, Brussels, Belgium.
Shipley, Prof. Arthur E., Christ's College, Cambridge, England.
Silvestri, Dr. F. R., Scuola Superiore di Agricoltura, Portici, Italy.

Theobald, Frederick V., Wye Court, Wye, Kent, England.
Thompson, Rev. Edward H., Franklin, Tasmania.
Tillyard, R. J., Cawthron Institute of Scientific Research, Nelson, New Zealand.
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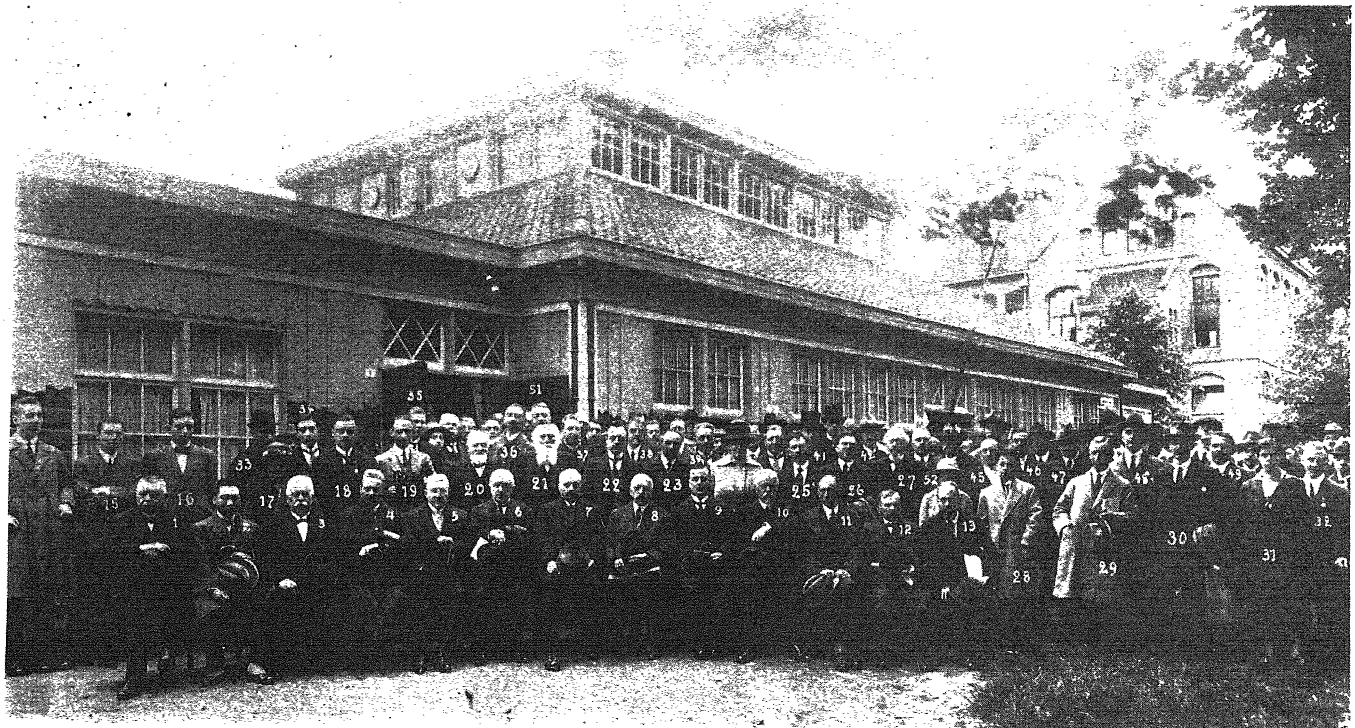

International Conference of Phytopathologists and Economic Entomologists,
held in Holland, June 24-30, 1923

Explanation of Plate 1

3. J. Eriksson, Sweden.
4. O. Appel, Germany.
5. Burgemeister of Wageningen.
6. Jonkheer S. Van Citters
7. Minister Int. Agriculture of Holland
8. L. O. Howard, U. S. A.
9. Dr. Kielstla, Holland.
10. L. Mangin, France.
11. J. C. F. Fryer, England.
12. V. Ducomet, France.
13. E. Foëx, France.
18. E. van Slogteren, Holland.
20. J. Ritzema Bos, Holland.
22. T. A. C. Schoevers, Holland.
23. G. B. Traverso, Italy.
24. Miss J. Westerdijk, Holland.
25. H. M. Quanjer, Holland.
26. R. Mayné, Belgium.
27. D. van Hove, Belgium.
30. I. Whitehead, England.
31. Miss Dorothy Cayley, England.
32. C. Boerner, Germany.
38. C. Moreira, Brazil.
47. H. T. Güssow, Canada.
48. A. Gibson, Canada.
49. H. Faës, Switzerland.
50. C. L. Shear, U. S. A.
51. N. van Poeteren, Holland.
52. Miss M. Bensaude, Portugal.

A number of important delegates do not appear in the group, notably Paul Marchal of Paris and Dr. Metcalf of Washington.

JOURNAL
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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGIST

VOL. 17 FEBRUARY, 1924 No. 1

Proceedings of the Annual Meeting of the American Association of Economic Entomologists

The thirty-sixth annual meeting of the American Association of Economic Entomologists was held at the University of Cincinnati, Cincinnati, Ohio, December 29, 1923 to January 2, 1924.

The Section on Apiculture convened at 10 a. m., December 29 and held a morning session. The meeting was adjourned at noon and the program completed at a later session.

The Section on Horticultural Inspection met on the afternoon of December 29. On the evening of December 31st, the Exension Entomologists held a conference at the Gibson Hotel, 60 members being present.

The opening meeting of the general association was called to order at 10 a. m., Monday, December 31, 1923, by President A. G. Ruggles.

The annual reports were read and the business of the opening session was transacted. The address of the President was delivered before the close of this session. The sessions were continued in the afternoon, throughout Tuesday and were concluded with a final business session on Wednesday.

Tuesday morning was devoted to a symposium on the "Methods of Estimating Insect Abundance and Damage" and on Wednesday morning a series of papers were given on the European Corn Borer problem. The entomologists' dinner was held Tuesday evening, January 1. One hundred and fifty entomologists were present.

During the meeting many of the members attended sessions held by Section N of the American Association for the Advancement of Science, The Entomological Society of America and the American Phytopathological Society, as well as sessions having programs of especial interest to economic entomologists.

The business proceedings form Part I of this report, and the addresses, papers, and discussion, Part II.

The proceedings of the Sections on Apiculture and Horticultural Inspection, together with a summary of the conference of extension entomologists, are also included.

PART I. BUSINESS PROCEEDINGS

The meeting was called to order by President A. G. Ruggles at 10 a.m. Monday, December 31, 1923. Over 200 members and visitors attended the sessions. The following members were present:

Ainslie, G. G., Knoxville, Tenn.
Babcock, K. W., Arlington, Mass.
Baerg, W. J., Fayetteville, Ark.
Balduf, W. V., Champaign, Ill.
Ball, E. D., Washington, D. C.
Barnes, D. F., Melrose Highlands, Mass.
Barnhart, R. P., Ocean Springs, Miss.
Bentley, G. M., Knoxville, Tenn.
Berger, E. W., Gainesville, Fla.
Bigger, J. H., Jacksonville, Ill.
Bilsing, S. W., College Station, Texas.
Bradley, W. G., Baton Rouge, La.
Britton, W. E., New Haven, Conn.
Bulger, J. W., Columbus, Ohio.
Burgess, A.F., Melrose Highlands, Mass.
Bynum, E. K., Gulfport, Miss.
Caesar, Lawson, Guelph, Canada.
Caffrey, D. J., Arlington, Mass.
Cagle, L. R., Knoxville, Tenn.
Cartwright, W. B., Centralia, Ill.
Chandler, S. C., Carbondale, Ill.
Claassen, P. W., Ithaca, N. Y.
Clausen, C. P., Berkeley, Calif.
Cockerell, T. D. A., Boulder, Colo.
Compton, C. C., Aurora, Ill.
Cook, Mel. T., Rio Piedras, P. R.
Cooley, R. A., Bozeman, Mont.
Corkins, C. L., Laramie, Wyo.
Crawford, H. G., Ottawa, Canada.
Crossman, S.S., Melrose Highlands, Mass.
Cutright, C. R., Wooster, Ohio.
Davis, J. J., Lafayette, Ind.
Dean, G. A., Washington, D. C.
DeLong, D. M., Columbus, Ohio.
Dietz, H. F., Indianapolis, Ind.
Dozier, H. L., Mobile, Ala.
Eckert, J. E., Raleigh, N. C.
English, L. L., Ames, Iowa.
Eyer, J. R., St. Paul, Minn.
Fackler, H. L., Knoxville, Tenn.
Faxon, Richard, Columbus, Ohio.
Felt, E. P., Albany, N. Y.
Fenton, F. A., Ames, Iowa.
Flint, W. P., Urbana, Ill.
Ford, A. L., Brookings, S. D.
Fracker, S. B., Madison, Wis.
Frison, T. H., Urbana, Ill.
Frost, S. W., Arendtsville, Pa.
Garman, H., Lexington, Ky.
Garman, Philip, New Haven, Conn.
Gibson, Arthur, Ottawa, Canada.
Gillett, C. P., Fort Collins, Colo.
Glasgow, Hugh, Geneva, N. Y.
Glasgow, R. D., Urbana, Ill.
Glenn, P. A., Urbana, Ill.
Good, H. G., Ithaca, N. Y.
Goodwin, J. C., Gainesville, Fla.
Gossard, H. A., Wooster, Ohio.
Graf, J. E., Washington, D. C.
Granovsky, A. A., Madison, Wisc.
Gay, G., Knoxville, Tenn.
Guyton, T. L., Harrisburg, Pa.
Hamlin, J. C., Houston, Texas.
Harned, R. W., Agricultural College, Miss.
Hartley, E. A., Syracuse, N. Y.
Hartzell, Albert, Geneva, N. Y.
Hartzell, F. Z., Fredonia, N. Y.
Haseman, Leonard, Columbia, Mo.
Headlee, T. J., New Brunswick, N. J.
Hinds, W. E., Auburn, Ala.
Hine, J. S., Columbus, Ohio.
Hodgkiss, H. E., State College, Pa.

Hoffman, W. E., St. Paul, Minn.
Hopkins, A. D., Washington, D. C.
Horsfall, J. L., Bustleton, Pa.
Hough, W. S., Winchester, Va.
Houser, J. S., Wooster, Ohio.
Howard, L. O., Washington, D. C.
Howard, N. F., Birmingham, Ala.
Huber, L. L., Wooster, Ohio.
Hungerford, H. B., Lawrence, Kansas.
Hunter, S. J., Lawrence, Kansas
Hyslop, J. A., Washington, D. C.
Jewett, H. H., Lexington, Ky.
Kelley, E. G., Manhattan, Kansas.
Kennedy, C. H., Columbus, Ohio.
King, J. L., Washington, D. C.
Knull, J. N., Hummelstown, Pa.
Larrimer, W. H., West Lafayette, Ind.
Lathrop, F. H., Highland, N. Y.
Lewis, H. C., Columbus, Ohio.
Lockwood, Stewart, Billings, Mont.
MacGillivray, A. D., Urbana, Ill.
Marcovitch, S., Knoxville, Tenn.
Marlatt, C. L., Washington, D. C.
McBride, O. C., Columbia, Mo.
McColloch, J. W., Manhattan, Kansas.
McEvilly, J. E., McComb, Miss.
McGehee, T. F., Holly Springs, Miss.
McKay, R. S., Batavia, Ohio.
Mendenhall, E. W., Columbus, Ohio
Metcalf, C. L., Urbana, Ill.
Mickel, C. E., St. Paul, Minn.
Miller, A. E., Chillicothe, Ohio.
Moore, William, New York, N. Y.
Mosher, Edna, Brooklyn, N. Y.
Neiswander, C. R., Wooster, Ohio.
Ness, Henry, Ames, Iowa.
Noble, Willis B., West Lafayette, Ind.
O'Kane, W. C., Durham, N. H.
Osborn, Herbert, Columbus, Ohio.
Osburn, R. C., Columbus, Ohio.
Paddock, F. B., Ames, Iowa.
Painter, H. R., West Lafayette, Ind.
Park, Wallace, Ames, Iowa.
Parker, J. R., Bozeman, Mont.
Parks, T. H., Columbus, Ohio.
Parrott, P. J., Geneva, N. Y.
Patch, L. H., Sandusky, Ohio.
Patts, S. F., College Park, Md.
Peterson, Alvah, New Brunswick, N. J.
Phillips, E. F., Washington, D. C.
Poos, F. W., Sandusky, Ohio.
Price, W. A., Lafayette, Ind.
Quaintance, A. L., Washington, D. C.
Readio, Philip, Lawrence, Kansas.
Reese, C. A., Columbus, Ohio.
Riley, W. A., St. Paul, Minn.
Robinson, J. M., Auburn, Ala.
Rohwer, S. A., Washington, D. C.
Root, E. R., Medina, Ohio.
Ruggles, A. G., St. Paul, Minn.
Runner, G. A., Sandusky, Ohio.
Safro, V. I., Clarksville, Tenn.
Sanders, J. G., Philadelphia, Pa.
Sanders, P. D., College Park, Md.
Sasscer, E. R., Washington, D. C.
Satterthwait, A. F., Webster Groves, Mo.
Severin, H. C., Brookings, S. D.
Simanton, F. L., Benton Harbor, Mich.
Simmons, Perez, Silver Spring, Md.
Smith, L. B., Riverton, N. J.
Smith, M. R., Agricultural College, Miss.
Smith, R. C., Manhattan, Kansas.
Smith, R. H., San Francisco, Calif.
Snapp, O. I., Fort Valley, Ga.
Speaker, H. J., Sandusky, Ohio.
Spencer, G. J., Guelph, Canada.
Stearns, L. A., Leesburg, Va.
Strand A. L., Bozeman, Mont.
Sullivan, K. C., Columbia, Mo.
Sutton, F. J., Middleport, N. Y.
Strong, L. A., Washington, D. C.
Tanquary, M. C., College Station, Texas.
Taylor, L. H., Morgantown, W. Va.
Tissot, A. N., Columbus, Ohio.
Treherne, R. C., Ottawa, Canada.
Underhill, G. W., Richmond, Va.
Van Dine, D. L., State College, Pa.
Wade, J. S., Washington, D. C.
Watson, J. R., Gainesville, Fla.
Webster, R. L., Agricultural College, N. D.
Whitmarsh, R. D., Wooster, Ohio.
Williamson, Warren, Galesburg, Ill.
Worthley, L. H., Arlington, Mass.

PRESIDENT A. G. RUGGLES: The Association will please come to order. The first business is the report of the Secretary.

REPORT OF THE SECRETARY

The membership of the association at the time of the Boston meeting consisted of 299 active, 310 associate and 48 foreign, making a total of 657 members. At that meeting, 28 associate members were transferred to the active list, one active and three associate members resigned, 5 associate members were re-instated and 71 new associate members were elected. Since the annual meeting, 3 active and 12 associate members have been dropped for non-payment of dues and one active and one associate member has died.

The present membership is active, 322, associate, 342, foreign, 48, making a total of 712 and a net gain of 41.

On October 20, 1923, Mr. S. W. Foster died at San Francisco, Calif., following an operation for appendicitis. For a number of years he was employed by the Bureau of Entomology on deciduous fruit insect investigations, but for several years he has been connected with the General Chemical Company, having charge of their insecticide business on the West Coast. Mr. Foster was a skilled entomologist and was very successful in handling the business enterprise in which he was engaged. He had the respect and confidence of a wide circle of acquaintances.

The death of Mr. A. C. Lewis at Atlanta, Ga., was reported too late to appear in the previous report of the Secretary.

The annual meeting of the Pacific Slope Branch was held at Los Angeles, Calif., September 17–19. The meeting was well attended and the papers presented have been published in the December number of the JOURNAL OF ECONOMIC ENTOMOLOGY.

JOURNAL OF ECONOMIC ENTOMOLOGY

The Volume of the JOURNAL for 1922 consisted of 446 pages, for 1923, 568 pages, an increase in printed matter of 122 pages. This extra printed matter has been carried without increasing the price of subscriptions and this has been due in no small measure to the activity of Mr. C. W. Collins, who is Circulation Agent, and the members who have assisted him in securing new subscriptions. All members are requested to give as much help as possible in securing new subscriptions. By doing this it will be possible to increase the amount of matter that can be published in the JOURNAL and offer better facilities to members who may have short papers that they wish to publish.

The supply of back numbers is gradually being reduced. Already Volume 1 is out of print, with the exception of a few sets from which No. 2 is missing. The price of several volumes where the supply is beginning to run low, will be increased in the near future. Until this is done, all except volume 1, will sell for $3.50 each.

INDEX TO THE LITERATURE OF AMERICAN ECONOMIC ENTOMOLOGY, I AND II

A number of copies of both of these books have been sold during the year. The cost of Index No. 1 has now been met and this book shows a balance. In the case of Index No. II, there is still a deficit of $225. It is hoped that there will be sufficient sales during the coming year so that this amount can be paid.

PERMANENT FUND

In accordance with instructions from the Executive Committee, $500 was trans-

ferred from the Association Fund to the Permanent Fund, immediately following the last annual meeting. The interest on bonds and on savings bank deposit has been credited to the fund as shown in the financial statement.

Association Statement

Balance in Treasury, December 2, 1922		$614.05
Amount received from dues, 1922		665.50
Amount received from Malden National Bank, Interest		14.19
Amount received from Loans		100.00
Paid—Stenographic report, 1922 meeting	$136.68	
Postage	62.59	
Programs and Notices	18.00	
Supplies and stationery	44.50	
Telegraph and express	15.52	
Expenses Membership Committee	13.00	
Expenses Pacific Slope Branch	15.80	
Funds transferred	500.00	
Secretary	50.00	
Clerical work, Secretary's office	45.00	
Balance, December 4, 1923	492.65	
Grand Total	$1393.74	$1393.74

Balance, Deposited in First National Bank, Malden, Mass.

Journal Statement

Balance in Treasury, December 2, 1922		$730.41
Amount received from subscriptions, advertising, etc		3723.78
Amount received from Malden National Bank, Interest		22.00
Paid—Postage	$60.29	
Printing	2505.96	
Programs and Notices	14.50	
Supplies and stationery	48.61	
Half-tones	118.85	
Telegraph and express	5.47	
Returned checks	4.25	
Collection fees on checks	.49	
Editor	100.00	
Clerical work, Editor's office	75.00	
Secretary	50.00	
Clerical work, Secretary's office	45.00	
Balance, December 4, 1923	1447.77	
Grand Total	$4476.19	$4476.19

Balance, Deposited in First National Bank, Malden, Mass.

Index I Statement

Balance in Treasury, December 2, 1922		$160.94
Received from sales		161.90
Amount received from Interest		7.70

Received from Loans		100.00
Paid for postage	$5.16	
Balance, December 4, 1923	425.38	
Grand Total	$430.54	$430.54

Balance, Deposited in Melrose Trust Company, Melrose, Mass.

INDEX II STATEMENT

Balance in Treasury, December 2, 1922		$1.27
Received from sales		211.50
Paid for postage	$6.18	
Paid for Loans	200.00	
Balance, December 4, 1923	6.59	
Grand Total	$212.77	$212.77

Balance, Deposited in Malden National Bank, Malden, Mass.

PERMANENT FUND

Deposit, Melrose Savings Bank, Dec. 2, 1922	$734.75
Deposit, Melrose Savings Bank, Feb. 1, 1923	500.00
Interest on Deposit, Dec. 4, 1923	33.08
Interest on Liberty Bonds	25.50
Deposit, Melrose Savings Bank, Melrose, Mass.	$1293.33
4¼% Liberty Bonds	600.00
Grand Total	$1893.33

4¼% Liberty Bonds—$600
Deposited in Melrose Savings Bank—$1293.33

SUMMARY

Balance in Index I account, Dec. 4, 1923	$425.38
Balance in Index II account, Dec. 4, 1923	6.59
Balance in JOURNAL account, Dec. 4, 1923	1447.77
Balance in Association account, Dec. 4, 1923	492.65
Grand Total	$2372.39

Respectfully Submitted,
A. F. BURGESS, *Secretary*

Voted that the report be accepted.

PRESIDENT A. G. RUGGLES: The next is the report of the Circulation Agent, which will be read by the Secretary.

REPORT OF CIRCULATION AGENT, 1923

A report showing some progress for the increase in the number of subscriptions to the JOURNAL was given before the Association of Economic Entomologists at the Boston meeting in December 1922. The writer together with the same leaders in the states and in the Provinces of Canada with few exceptions have continued their

efforts along the same line in 1923. Printed circulars describing the scope and usefulness of the JOURNAL to which a subscription order blank was attached have been distributed by the leaders and myself to all possible subscribers thought to be interested.

A considerable number of subscribers were secured in 1922 who later found themselves not sufficiently interested in economic entomology, consequently dropped the publication after one year. We all realize that a specific scientific journal of this kind has its circulation limits. Our best prospect of increased circulation (as has been principally in the past) seems to be among domestic and foreign educational institutions to do with agriculture, city public libraries, and men entering the field of entomology as a livelihood. Let every member of this Association bear this in mind and feel it his duty to interest a new subscriber in any case where he feels that a potentiality has been overlooked. Such cooperation is for the mutual benefit of us all—netting more money for a bigger and better JOURNAL.

The following table shows the total domestic and foreign subscribers in 1913, 1921, 1922 and 1923.

	1913	1921	1922	1923		1913	1921	1922	1923
Alabama	3	7	12	9	Nebraska	3	4	2	3
Arizona	7	5	6	8	Nevada	1	2	2	2
Arkansas	2	5	6	4	New Hampshire	4	7	7	9
California	34	65	63	67	New Jersey	14	22	23	22
Colorado	7	15	14	12	New Mexico	3	4	3	3
Connecticut	10	15	20	15	New York	52	40	61	69
Delaware	3	2	3	3	North Carolina	6	10	9	8
Dist. of Col.	50	42	53	55	North Dakota	0	2	1	1
Florida	7	17	20	15	Ohio	22	32	33	34
Georgia	6	9	9	10	Oklahoma	2	4	4	5
Idaho	2	6	4	6	Oregon	10	12	11	12
Illinois	30	25	28	31	Pennsylvania	18	33	39	38
Indiana	16	13	13	15	Rhode Island	3	1	2	7
Iowa	5	14	12	12	South Carolina	4	3	1	2
Kansas	16	16	17	16	South Dakota	1	2	2	2
Kentucky	4	4	6	5	Tennessee	6	10	11	11
Louisiana	12	15	13	17	Texas	16	24	25	21
Maine	5	6	5	7	Utah	8	13	13	9
Maryland	11	8	10	14	Vermont	1	1	1	1
Massachusetts	48	70	83	76	Virginia	7	14	15	16
Michigan	15	10	12	10	Washington	8	12	12	8
Minnesota	10	13	14	14	West Virginia	5	5	5	5
Mississippi	4	19	25	22	Wisconsin	6	11	15	13
Missouri	8	10	13	12	Wyoming	0	1	1	2
Montana	5	7	9	7					
Total for U. S.						520	687	768	765
U. S. Poss.						26			
Hawaii							10	11	11
Panama & Virgin Islands							3	2	2
Philippines							5	5	5

P. R. & Cuba		6	6	7
Canada	27	37	43	47
Foreign	132	148	163	183
Grand Total	705	896	998	1020

It will be noted that the total subscriptions in the United States have remained about the same in 1923 as in 1922 while the foreign have increased substantially. If it had not been for the decided increase in foreign subscriptions during the past year the totals would have shown a decrease, and if foreign countries can make such a showing under present conditions abroad it would seem as though there is still a fair chance to do likewise at home.

I wish to thank all leaders in the various States and in the Provinces of Canada for their continued cooperation and help and ask that they continue with renewed interest for 1924.

Respectfully submitted,

C. W. Collins, *Circulation Agent.*

Voted that the report be accepted.

President A. G. Ruggles: I will now read the report of the Executive Committee.

REPORT OF EXECUTIVE COMMITTEE

Following instructions from the last annual meeting a delegate to the International Conference of Phytopathology and Economic Entomology at Wageningen, Holland was appointed. Dr. L. O. Howard, Chief of the Bureau of Entomology, U. S. Dept. of Agr. was chosen. It afterwards developed that Mr. Arthur Gibson, Dominion Entomologist of Canada, expected to attend this Conference. He was also appointed a delegate.

A committee composed of Messrs. Flint, Tanquary and De Long was appointed to consider and report at the Cincinnati meeting on the proposed amendments to the constitution and by-laws.

As considerable interest developed in the sectioning of the Association a committee consisting of Messrs. Davis, Hyslop, Dean and Burgess was appointed to consider the matter and make recommendations.

An invitation to send a delegate to the Centenary Celebration of the Birth of Joseph Leidy at Philadelphia, Dec. 6, 1923 was received by the Association and C. H. Hadley, Director Bureau of Plant Industry, Harrisburg, was chosen to represent the Association.

The committee has examined, and audited the accounts of the Secretary and found them to be correct.

This committee recommends that four hundred dollars of the unexpended balance in the Association fund be transferred to the permanent fund.

The committee also recommends that the Secretary be authorized to invest a portion of the permanent fund in U. S. Liberty Bonds.

Signed,—

A. G. Ruggles P. A. Glenn
H. A. Gossard S. B. Fracker
H. J. Quayle A. F. Burgess

Executive Committee.

Voted that the report be accepted and the recommendations adopted.

PRESIDENT A. G. RUGGLES: We will now listen to the report of the Delegate appointed to attend the International Conference of Phytopathology and Economic Entomology at Wageningen, Holland.

REPORT OF THE INTERNATIONAL CONFERENCE OF PHYTOPATHOLOGISTS AND ECONOMIC ENTOMOLOGISTS HELD IN HOLLAND, JUNE 24–30, 1923

Mr. President and Members:—The international conference held at Wageningen last June was the first international gathering which professedly in its title brought together the plant-disease men and the agricultural entomologists. As a result it was largely attended by both types of workers. Some time in advance of the meeting I received a letter from the President of this Association appointing me an official delegate. Later, on learning that Mr. Arthur Gibson was to be in Europe at that time, President Ruggles sent him, through me, official papers entitling him also to represent this Association.

Mr. Gibson and I were greatly delighted to find that the conference had attracted men from many lands. Twenty-two countries were represented if we include in the count British dominions, like Canada and Australia, as distinct countries. The majority of the delegates were from European countries, but Japan and China and Australia and Brazil sent delegates. From the United States, Dr. C. L. Shear and Dr. Haven Metcalf, both phytopathologists, were present, Dr. H. T. Gussow joined Mr. Gibson from Canada and Dr. Rudolph of the New Jersey Experiment Station, a Hollander, was home on vacation. In the enumeration I have also counted the Dutch East Indies as a distinct country. The new European governments of Ireland, Czecho-Slovakia and Poland were represented. The original list as published in the program of the conference was altered in a number of respects. Several important men who appeared in the original list were unable to attend, and a few others whose names did not occur in the original list were present. Professor Jaczewsky of Russia was absent, but Russia was represented by Dr. Alexander Buchheim, also a phytopathologist. Dr. Paul Marchal of France, who was not in the original list, was able to join the conference at the last moment. The countries represented were,—

Holland	Canada
Germany	Denmark
Hungary	Japan
Czecho-Slovakia	Dutch East Indies
France	Belgium
England	United States of America
Ireland	Austria
Russia	Finland
Sweden	Australia
Switzerland	China
Poland	Italy

Meetings were held Sunday evening, June 24, and all day Monday and Tuesday in the great hall of the University of Wageningen (the old Agricultural College has been made a university). The seating space was surrounded by wall and window

exhibits of different kinds. The address of welcome was delivered by Dr. J. C. Kielstra, the *Rector Magnificus* of the University, and was responded to on behalf of the delegates by the writer who had been made the Honorary President of the conference. On Monday the opening address of the conference was given by the Netherland Minister for Home Affairs and Agriculture, and during the morning of Monday the Potato Disease Laboratory, recently constructed, was inaugurated by an address from the president of the board of trustees of the university.

On Wednesday and Thursday trips were taken by the delegates through interesting regions in Holland, and on Friday the sessions for the reading of papers were resumed at Baarn, at the Laboratory for Phytopathology, under the directorship of Miss (Doctor) J. Westerdijk.

A number of interesting and important papers were read by the different delegates, all of which will appear in the published proceedings and need no comment in this report.

The final business session was held at Baarn on Saturday morning, and at this meeting, following resolutions introduced by Prof. Mangin of France, a permanent organization was formed, with Doctor Quanjer (who had been the Acting President during the conference) as President and a board of twelve to arrange the program of the next conference and to act upon matters which may come up in the interim. On this board there are two American members, Dr. C. L. Shear and the writer, who will represent not only the United States but the republics of Central and South America.

An important action of the conference in perfecting its future organization was the decision as to the title. In his opening address the writer had complimented the organizers of the conference on their adoption of the title "Conference of Phytopathologists and Economic Entomologists," urged the continued use of the title in any permanent organization and suggested that future meetings should be divided into two sections which should hold independent sessions and general sessions on matters of mutual interest. There was much discussion and much difference of opinion in the conference on this point. The adoption of the term *phytopathology* as including agricultural entomology in European countries is so general that the title under which the 1923 conference was held was not pleasantly greeted by many of the delegates. A large number of the phytopathologists insisted upon the retention of the European signification of the word as including the study of injurious insects, many of the German-speaking delegates preferred their own term "pflanzenschutz," or "crop protection," as including the whole idea. The final adoption of a title was discussed vigorously and the delegates were divided as to whether they should be termed "international conferences for phytopathology and economic entomology" or "international conferences for crop protection." The final vote resulted in 33 for the dual name and 23 for the title "crop protection." It was noticeable that all of the delegates from English-speaking countries voted unanimously for the joint title whether they themselves happened to be phytopathologists or economic entomologists, whereas the delegates from German-speaking countries were unanimously in favor of the single title. The delegates from France and Belgium were divided in opinion, as were those of Holland.

There was much discussion, in the course of the conference, of matters of quarantine. Doctor Gussow of Canada read an important paper, dealing with this matter, which was vigorously discussed. Doctor Kielstra, himself an economist, attacked

the plant quarantine idea from the standpoint of an economist, and of course the influence of our own Quarantine 37 was apparent in the animus of many speeches which were made both at the conference and at informal receptions and lunches of which there were a number. The writer of this report was rather glad, on the whole, that none of the members of the U. S. Federal Horticultural Board were present, although he does not doubt in the least their ability to defend their attitude.

The excursions to different points of agricultural and horticultural interest were extremely interesting, and the hospitality shown to the conference by the people in Holland was very marked. The final dinner which occurred on the last night of the conference at Scheveningen, a beautiful seaside resort, was given to the conference by the government of Holland, and at its close a telegram of thanks was sent to the Queen of Holland who was at that time in England.

While your delegate was the Honorary President of the conference, the sessions were conducted by the Active President, Dr. H. M. Quanjer, who showed an extraordinary degree of tact and courtesy and such a perfect familiarity with the English, French and German languages that he made an ideal executive for such a conference where many languages were spoken. Although the official language of the Conference was English, papers were also read in French and in German. The Secretary of the conference, Dr. T. A. C. Schoevers, like so many Hollanders, was equally familiar with the languages mentioned, and was extremely competent in performing the manifold duties of the secretary of an international affair.

The delegates were especially pleased to meet Dr. Ritzema Bos, for many years prominent in the phytopathological and entomological world, who is now retired but who attended all of the sessions at Wageningen.

This report should not be concluded without a further statement in regard to the writer's effort to secure the recognition of economic entomology as an independent branch of applied science. Realizing that the acceptance by the International Institute of Agriculture at Rome of the European signification of the term *phytopathology* had in a way rather fixed this meaning, he has endeavored to secure a modification of the title of the section in question of the Institute. The following letter was sent to the Institute last August through the Secretary of Agriculture:

The Honorable August 15, 1923.
The Secretary of Agriculture.
Dear Mr. Secretary:

I wish to suggest that a recommendation be sent to the International Institute at Rome for consideration at the next general assembly of the Institute which I understand will be held in May, 1924. The suggestion which I wish to make may be worded as follows:

> The United States suggests that the International Institute of Agriculture change the name of the bureau now entitled "Bureau of Agricultural Intelligence and Plant Diseases" to "Bureau of Agricultural Intelligence and Plant Protection."

My reason for proposing this change is that under the present bureau all matters relating to insect damage to plants are considered under the head of "plant diseases." It is difficult to see how, logically, an insect which feeds upon a plant may be considered as a plant disease; and yet this construction is made by several European nations who use the terms "phytopathology" and "maladies des plantes" as including investigations of insects that feed on plants. In most English-speaking countries a clear distinction is drawn between economic entomology (the study of injurious insects) and phytopathology (the study of diseases of plants). The suggested change is obviously desirable, since it will insure a heartier cooperation on the part of the large governmental services which exist in many countries for the study of injurious

insects. It may be of interest to add that, recognizing this fact, the French have recently changed the name of their national Société de Phytopathologie by adding the words "et Entomologie Agricole;" and that at a recent international conference held at Wageningen a permanent organization was formed to be entitled "International Union of Phytopathologists and Economic Entomologists."

Respectfully,
L. O. HOWARD,
Chief of Bureau.

A reply has been received from the American representative at the Institute, Mr. Asher Hobson, which reads as follows:

Rome, Oct. 12, 1923.

Dr. L. O. Howard,
Chief, Bureau of Entomology,
U. S. Department of Agriculture,
Washington, D. C.
Dear Dr. Howard:

Your letter of August 15, addressed to the Secretary of Agriculture, has been forwarded to me. This letter suggests that the next General Assembly of the Internaional Institute of Agriculture at Rome consider the advisability of changing the name of the "Bureau of Agricultural Intelligence and Plant Diseases" to "Bureau of Agricultural Intelligence and Plant Protection."

At the first opportunity, I shall place your suggestion before the 3rd Commission, which deals with matters pertaining to the Bureau of Agricultural Intelligence and Plant Diseases. If I am unable to secure favorable action in this Commission, I shall then attempt to get the question put on the agenda for discussion at the next General Assembly.

Yours truly,
ASHER HOBSON,
Delegate of the United States.

From this it seems that the matter will be presented in a proper manner to the Institute at an early date. The writer suggests the advisability of the passage of resolutions by this Association endorsing the proposed change at Rome.

There is another matter upon which the writer may take this occasion to report. In 1920 he was authorized to interview European entomologists with the suggestion coming from the Committee on Policy of this Association that it might be well to organize a European Association of Economic Entomologists. It was found that at that time such a movement was undesirable or impractical for many reasons. The writer has now to report, however, that such a movement is being gradually worked out. Monsieur Raymond Poutiers, of Menton, has been discussing the matter with a number of French, Italian and Spanish entomologists, and the idea is proposed that the economic entomologists of these countries, together with those of the colonies on the other side of the Mediterranean and those of Portugal, should call an initial conference and form an organization to which subsequently there shall be admitted the more northern European countries such as England, Belgium, Holland, Denmark, Norway, Sweden, Germany and the others. The idea is still in the correspondence stage, and no active steps have as yet been taken.

Respectfully submitted,
L. O. HOWARD

The following letters have just been received from the Secretary, Dr. Schoevers and the President of the Conference, Dr. Quanjer.

Dear Sir,

I have pleasure in forwarding herewith a copy of the Report of the International Conference of Phytopathology and Economic Entomology.

In the circular which was sent to you together with the program, the Committee has promised to present each member with a copy of the Report. At the time the Committee could not foresee that the Report would fill so extensive a volume, with many coloured and black plates. With the Report at hand you will no doubt apprehend that the printing expenses have by far exceeded the estimate. Therefore it will not be possible to sell the Report at the price mentioned in the circular referred to above, it is absolutely necessary to raise the selling price to fl. 4.– (=$1.60=7=28 fr. frs.=8.7 sw. frs) free of expedition charges, for members f 3.75 (=$1.50=6/4=26 fr. frs=8 sw. frs.)

The Committee will be highly pleased if the members of the Conference will take their share in the expenses by paying for their copy if possible. If you are willing to grant this request, please foward a postal order (f 3.75) to the Secretary.

Furthermore you can aid the Committee by trying to sell more copies if through your kind interference some of your colleagues or other interested persons or institutes would order a copy, the whole issue of 1000 copies might be sold. This object would also be greatly furthered by referring to the report in recommending notes in the periodicals.

Orders for a copy are to be addressed to the Secretary.

Yours truly
T. SCHOEVERS,
Secretary,
Wageningen.

TO THE PLANT PATHOLOGISTS AND ECONOMIC ENTOMOLOGISTS OF THE WORLD

The undersigned is much impressed by the great interest taken by his colleagues from abroad in the first Conference of Phytopathology and Economic Entomology. Not only that the hope has been expressed by the attendants that similar Conferences may be held every second or third year, but also several of them expressed the wish of more regularly being informed about the research work going on in those countries, which on account of their language, have difficulties in making their results known abroad. The bigger countries have their Journals which are being read everywhere in the world, the present report shows that countries whose language is not spoken internationally, e. g. Denmark, Hungary, Greece, Sweden, Russia, Lithuania and Holland, are also contributing their share to the advance of these sciences but they have no such periodicals in which they could publish in an international language. It may be to the general benefit of all concerned to combine research papers from these countries in one International Journal of Plant Pathology and Economic Entomology, published in English, French and German. There is no doubt that a volume of about the same size as the present Report could be issued every year. If desired it could easily be arranged that these volumes, together with the Reports of future International Conferences should form one series.

The decision as to whether or not the undersigned will undertake the redaction and publishing of such a permanent international journal (in which the Reports of Conferences may be intercalated as additional volumes) rests largely with all the workers in this field. Unless there is forthcoming from them a sufficiently repre-

sentative sentiment in favour of such an undertaking and substantial support for its execution, it is clear that he will not be in a position to embark in this task. In case that there could be secured 600 subscriptions the price of each volume of the Journal, appearing annually in the same size as the present report,

will amount to	$2½	(postage free)
for 500 subscriptions	$3	" "
for 400 "	$3½	" "
for 300 "	$4	" "

In order to remove all uncertainty about this undertaking the colleagues abroad are asked to express their opinion whether they will subscribe at once so that their answers for which they can use the inclosed postcard, can be received before January 25th, 1924.

H. M. QUANJER.

Voted that the report be accepted.

PRESIDENT A. G. RUGGLES: The next business is the report of the Representative to the National Research Council.

REPORT OF THE REPRESENTATIVE TO THE NATIONAL RESEARCH COUNCIL

The annual meeting of the Division of Biology and Agriculture for the election of officers for the ensuing year, the consideration of reports of the sub-committees and the transaction of general business, was held on April 22 in the offices of the National Research Council, Washington, D. C. Dr. R. A. Harper of Columbia University was elected chairman of the division. The most important matters recently before the division were that of the National Research Fellowships in the Biological Sciences and the Formation of a Union of American Biological Societies.

The National Research Council has been entrusted by the Rockefeller Foundation with the expenditure of a sum of $325,000, available between July 1, 1923, and June 30, 1928, to promote research in the biological sciences, including zoology, botany, anthropology, and psychology, by post-doctorate research fellowships. "These fellowships will be awarded to persons in relatively early stages of a research career for the purpose of enabling them to continue research at suitable institutions, preferably in the United States. The purpose of the National Research Fellowships in the Biological Sciences is the promotion of fundamental research in these subjects. This involves not only the immediate acquisition of more knowledge through research, but also the securing of a greater number of thoroughly trained investigators. It is hoped that the establishment of such fellowships may prevent the loss of research interest in the early post-doctorate years by the premature or excessive absorption of promising investigators in routine duties and may also improve the conditions for research in the educational and other scientific institutions of this country."

Dr. Frank R. Lillie, Professor of embryology, University of Chicago, and formerly Chairman of the Division of Biology and Agriculture of the National Research Council, was appointed by the National Research Council Chairman of the Board of National Research Fellowships in the Biological Sciences. All communications or inquiries of information concerning the fellowships should be addressed to the

Secretary of the Board of Fellowships in the Biological Sciences, National Research Council, Washington, D. C.

The formation of a Union of American Biologial Societies, which has been a major project of the Division of Biology and Agriculture, has now reached a successful issue. The Union was organized in April, 1923, with the following member societies:

American Association for the Advancement of Science,
  Sections F, G, N, and O.
American Association of Anatomists
American Association of Economic Entomologists
American Dairy Science Association
American Genetic Association
American Physiological Society
American Phytopathological Society
American Society of Agronomy
American Society for Horticultural Science
American Society of Naturalists
American Society of Zoologists
Botanical Society of America
Ecological Society of America
Entomological Society of America
Society of American Foresters

As stated by the Secretary of the Union: "The Union of the American Biological Societies and the Division of Biology of the National Research Council are cooperating in an endeavor to develop and finance a feasible plan for providing a stable, comprehensive and adequate system of abstracts and indexes for our biological articles." The committee of these two cooperative bodies has made a report in *Science*, a copy of which was mailed to the members of this Society. As stated in their report: "Unless there is forthcoming from you a sufficiently representative sentiment in favor of such an undertaking and a substantial assured support for its execution, it is clear that the Union will not be in a position to embark on the gigantic task."

Your representative on the National Research Council stated in his report to the Division of Biology and Agriculture of the National Research Council that the American Association of Economic Entomologists was very much interested in the proposed American Tropical Plant Research Institute, and as a representative of the American Association of Economic Entomologists on the National Research Council, he desired to assure the proposed Institute of the cooperation of the Economic Entomologists. It was also stated that, since some of the principal objects of the Institute are to conduct investigations in plant pathology and entomology, and to discover and apply methods of control for plant pests, the Economic Entomologists would appreciate representation of their association on the Board of Control and Advisory Board of the proposed Institute. Mr. D. L. Van Dine, Pennsylvania State College, has been appointed on this board. GEO. A. DEAN,

Representative of the American Association of Economic Entomologists to the National Research Council.

Voted that the report be accepted.

PRESIDENT A. G. RUGGLES: The report of the Committee on Policy will now be presented.

REPORT OF THE COMMITTEE ON POLICY

The personnel of the subcommittees during the current year is as follows:
EDUCATION—Mr. Dean, Chairman, Mr. Ruggles, Dr. Newell.
INSECT CONTROL—Dr. Felt, Chairman, Mr. Burgess, Mr. O'Kane.
ORGANIZATION—Dr. Newell, Chairman, Mr. O'Kane, Mr. Dean.
RESEARCH—Dr. Ball, Chairman, Dr. Swaine, Mr. Parrott.
PUBLICATION—Mr. Burgess, Chairman, Dr. Felt, Mr. Ruggles.

In addition to correspondence and personal interviews with individual members' one meeting of the entire Committee on Policy was held at the Gibson Hotel, Cincinnati, Ohio, on Saturday evening, December 29.

On May 31 a letter was received from Dr. J. R. Schramm, Executive Secretary of the Division of Biology and Agriculture of the National Research Council, relative to the continuation of the Committee on Cooperation with the Division. It was pointed out that the committees of the different scientific societies had individually been very useful during the first years of the Council's existence, but at the present time most of them were relatively inactive. As simplification of committee appointments and a reduction of the machinery to those elements which were obviously most serviceable could hardly fail to increase the effectiveness of the organization of the National Research Council, it was voted that the Committee of Cooperation be discontinued, since the officially elected representative of our Association provided sufficient contact with the Council.

The Committee on Policy would recommend for consideration the possibility of establishing a series of lectures at Entomological centers. These lectures should be on such broad subjects as History of Entomology, including Insect Paleontology, General Insect Morphology, General Insect Taxonomy, Biometrics, General Ecology, and Physical Chemistry as applied to Insecticides.

As the Crop Protection Institute was organized for the promotion and maintenance of research in connection with insect and other plant pests under the sponsorship of this Association and the National Research Council, its work and policies are of vital interest and concern to our members and may properly be considered by the Committee of Policy.

An examination of the affairs of the Institute lead the committee to believe that it is being wisely and effectively directed and that it is making steady progress. Considering the fact that the Institute is a new enterprise and wholly self-supporting, the activities of the past year show creditable achievements, its support of five research projects of fundamental importance constituting the outstanding accomplishment. This progress affords the Association justifiable satisfaction and confirms our belief that the Institute can serve as the right kind of a medium between industrial organizations and state experiment stations and universities.

The promising results obtained with new insecticides during recent years have emphasized the importance of chemistry in the warfare against insects. Notwithstanding the notable progress that has been made, the chemistry of insecticides is, for the most part, an undeveloped field and large possibilities undoubtedly exist for the widening and deepening of our fundamental knowledge. It is a branch of effort that should receive more profound and concentrated attention than has been manifested in the past. To accomplish this end the outstanding need is unquestionably for more thoroly trained chemists who should give their undivided efforts to de-

termining the properties of chemical agents in relation to their effects on insect life and elucidate the applications of chemistry to entomological procedure.

Another constructive step would be to develop a larger degree of cooperation between chemists in insecticides and entomologists as the workers in these two fields need the information and point of view of the other to supplement their special skill and knowledge.

A third need is the broadening of the academic training of students in entomology. An examination of the applications for research fellowships of the Crop Protection Institute has revealed a lack of training and aptitude on the part of many of the candidates, considered in the light of the technical ability demanded by the problems which were to be attacked. Most of these research projects call for investigations largely of a chemical nature. It would appear that present methods of training research students is not calculated to give solutions to some of the important problems that confront us, and it is evident that there is need of a larger number of workers who have a thoro acquaintance with the principles of chemistry, plant physiology, and other subjects besides those of entomology. The colleges could render great service in stressing the needs along these lines and facilitating the efforts of students who are found to possess appropriate talents or have a bent towards activities of this character. It cannot be denied that we are confronted with problems that have been developed as far as they are capable of yielding results by present research abilities and technique commensurate with the expenditure of time and energy given them, and that, as far as these are concerned, we are entering or shall soon enter the stage of diminishing returns unless there is a sharpening of the tools of the entomologist.

P. J. Parrott, E. W. Ball
A. F. Burgess, E. P. Felt
A. G. Ruggles, J. M. Swaine
Geo. A. Dean, Wilmon Newell
W. C. O'Kane, *Committee.*

Voted that the report be accepted.

President A. G. Ruggles: The next is the report of the Trustees of the Crop Protection Institute.

REPORT OF THE TRUSTEES OF THE CROP PROTECTION INSTITUTE

The plan under which the Crop Protection Institute operates has remained unchanged during the past year. Its affairs are controlled, as they have been from the start, by a Board of Governors made up of scientific men named by the national associations and by the National Research Council.

I think the Institute has made definite progress this year in the matter of its standing with experiment station directors, university presidents and officers in that group.

Two or three years ago when the Institute was first organized it was an untried experiment. At the present time it enjoys the cooperation of the heads of established institutions to a marked degree, and that means that its work is facilitated and its future is pretty well assured.

The Institute is administering six special funds for definite projects. These funds are not for the maintenance of the work of the Institute in general but are for special undertakings. Their total is $41,100.

The Institute has published in the past year one research bulletin. It has on hand additional manuscripts representing research work in sulphur, both in the insecticidal and the fungicidal phases, and a manuscript representing investigational work in calcium arsenates. It is continuing its informal news letter from month to month.

There are now about 300 scientific members and about 25 industrial members.

Plans for this year include various further investigational projects.

Respectfully submitted,
W. C. O'KANE, *Chairman*

Voted that the report be accepted.

PRESIDENT A. G. RUGGLES: We will now listen to the report of the Representative on the Council of the Union of American Biological Societies.

REPORT OF THE REPRESENTATIVES ON THE COUNCIL OF THE UNION OF AMERICAN BIOLOGICAL SOCIETIES

Your representatives took part in the organization meeting of the Union of American Biological Societies which convened in Washington April 26, 1923. An account of this meeting was published in the Oct. 5, 1923 issue of *Science* and which doubtless has been seen by most of the membership of this association. The by-laws which were adopted at this meeting were given in this article and need not be quoted here.

Section 9 of the by-laws however may be of interest as bearing on the methods provided for obtaining funds to meet current expenses of the Union, and is as follows: "The Council shall have power to receive and administer funds for the promotion of the purposes of the Union. Investments shall be made by the Treasurer with the advice and consent of the Executive Committee. For the defraying of current expenses the Council shall recommend assessments upon the member societies to be distributed in such manner as the Council shall determine."

The report of the "Joint Publications Committee" was presented and discussed at length by the representatives of the societies present. The report of this committee appeared in *Science*, Vol. *58* No. *1500* page 236 and was distributed in leaflet form to the membership of this association by the Secretary of the Council, Prof. I. L. Lewis, under date of Oct. 12. It may be concluded therefore that the members are fully advised as to the character of this report. It will be recalled that figures were given showing the cost of manufacture and distribution of 12 monthly numbers of an abstract journal, and which to each of the 6,000 individual members of the societies involved, would be $6.20. This estimate does not include editorial, bibliographic and clerical expenses. It is hoped that the efforts of the National Research Council to secure adequate support for an International Scientific Bibliography and abstracting, will serve to support at least a considerable part of this overhead.

There was some difference of opinion among the delegates present at the organization meeting as to the advisability of publishing a single comprehensive system of abstracts and indexes for all of the biologic sciences, or whether separate reports should be issued covering the work of the respective groups. In order to obtain the opinion of the individual members of the various constituent societies, Prof. I. F.

Lewis, Secretary of the Council under date of Oct. 12 circularized the members requesting that they indicate their preference in this matter. It is assumed that all of the members of this association received this letter (along with the reprint from *Science* giving the report of the Joint Publications Committee) and have already advised the secretary as to their wishes. The undersigned have no information as to what recommendations will be made in this particular, but assume that the results of the Secretary's canvass will be made known at the next meeting of the Council, which will doubtless occur in the near future.

Your representatives at the meeting of the Council were much impressed with the arguments in favor of an adequate system of biologic abstracts and indexes and feel that the aims and purposes of the council in conjunction with the Executive Committee of the Division of Biology and Agriculture, of the National Research Council, warrant the active support of the association of economic entomologists.

Respectfully submitted,

A. L. Quaintance
William Moore
Representatives

Voted that the report be accepted.

President A. G. Ruggles: The next report is by the Committee on Nomenclature.

REPORT OF THE COMMITTEE ON NOMENCLATURE

Your Committee, in pursuance of the project assigned to it and acting with the authority conferred upon it at the last meeting of this Association, is submitting herewith 310 new names with the recommendation that these names be adopted as official names of the American Association of Economic Entomologists. We are also submitting 40 changes in names which have been adopted by the Association as a result of previous Committee reports, with the recommendation that these new names be substituted for the names now recognized as official. In addition to the above two lists is a list of 24 names which the Committee suggests be used tentatively until such time as these insects, either by attracting increased attention of the economic workers or for other reasons, assume such importance that they warrant official recognition. We do not think it advisable that these names be accepted as official names of the Association at the present time.

To obviate the almost impossible task of considering each of the proposed names individually, on the one hand, and accepting the entire list without due consideration on the other hand, your committee proposes that the list of names proposed be prepared in mimeographed form and a copy sent to each active member of the association. Objections, substantiated by reason, to any name should be directed to the secretary of this committee early enough to be in his hands on or before March 1, 1924.

All names to which objection is raised will be stricken from the list and the so abridged list with all names previously adopted by the association and not affected by this report to be published in the Journal of Economic Entomology. We further recommend that 1,000 or more separates be printed and offered for sale.

The names to which exception is taken will be reconsidered by the committee and the amended name submitted to the Association with the next report of this committee.

The rules and usages that have been followed in preparing this list were outlined in the last report of this Committee (Jnl. Econ. Ent. Vol. 16, No. 1., p. 21–23). One of the greatest difficulties encountered in this work was the defining of a group name. You will recall that the fourth of the rules adopted at the last meeting of the Association as a guide in forming names, bears reference to compounding words in making group names, with particular reference to the use of the hyphen and "run-together," inasmuch as a group of insects can be based on almost any ground and it would not be in keeping with the Committee's conception of what constitutes a common name to adhere to an academic classification. This Committee has arbitrarily accepted certain terms as being group terms, for example, tent-caterpillar (hyphenated), leaf-miner (hyphenated), sawfly (run together), and treehopper (run-together), while on the other hand it has rejected other combinations which it believes are not as well defined as groups, for example, red scale, peach scale, root borer, etc. It is evident that these could be considered as groups and it is quite impossible to eliminate the personal factor in decisions of this kind.

This Committee recommends that the word "common" used as an adjective to designate a specific insect be discouraged. The term is extremely ambiguous, it might mean the insect most broadly distributed and it might mean the insect most numerous at any given place. Moreover, an insect which is common at one time is not necessarily common at another time. The common potato beetle at one time in this country was a blister-beetle, at present it is a Chrysomelid. Again, an insect may be common in one place and not common in another, for example; the common cucumber-beetle of the Eastern States is not the common cucumber-beetle of California. The Committee suggests that, in many cases, the idea intended to be conveyed by the word "common" is better expressed by the word "ordinary" inasmuch as this word does not necessarily signify immediate numerical superiority and conveys more the idea that it is a species most generally and longest known. It would be perfectly logical to say that the "ordinary cucumber-beetle" was not the "common cucumber-beetle" of California while it would be quite paradoxical to say that the "common cucumber-beetle" was not the "common cucumber-beetle" of California.

This Committee does not feel justified at this time in submitting a list of 1,000 new names for adoption inasmuch as this would have necessitated arbitraily fixing names on many insects which do not at present attract enough general attention to warrant the Association recognizing them officially.

It is suggested that the Association urge its members to forward all new and unapproved names, intended to be used in publication, to the Committee on Common Names for opinion before using.

It is the recommendation of this Committee that its successors add to this list as rapidly as thorough investigation of the names involved will permit, and we further recommend that a complete list of names adopted by the Association, including the changes suggested in this report and the additional names herewith suggested for adoption to be printed in the JOURNAL OF ECONOMIC ENTOMOLOGY and also issued as a separate.

Respectfully submitted,

EDITH M. PATCH   A. N. CAUDELL
Z. P. METCALF   J. A. HYSLOP
ARTHUR GIBSON   S. A. ROHWER
A. C. BAKER   *Committee*

MR. E. P. FELT: Is this list of 300 names in addition to the names already approved by the Association?

Mr. J. A. HYSLOP: There are about 300 new names and there is a short list changing some of the names that have previously been adopted. Most of the names previously adopted have been allowed to stand but are not included in the present list.

SECRETARY A. F. BURGESS: Some time ago I received a letter from Russia asking for copies of lists of common names of insects. Foreign entomologists frequently find it difficult to determine the exact insect referred to in American literature because different common names are used for the same insect and frequently the Latin name is not used at all. If the complete list is published, it will be very useful.

MR. L. O. HOWARD: Economic entomology is now so international that the scientific name of the insect should be used at least once in each article. We have been very lax in this matter and the name of the authority for the species should also be used.

Voted that the report be accepted.

PRESIDENT A. G. RUGGLES: The next is the report of the Committee on Index to Economic Entomology.

REPORT OF THE SPECIAL COMMITTEE ON THE PUBLICATION OF THE INDEX OF AMERICAN ECONOMIC ENTOMOLOGY

Indexes I and II have justified themselves and have met an urgent need. The former has more than paid for itself and sales of the latter indicate an early liquidation of all indebtedness in relation thereto. A series has been established which will be increasingly easy to maintain, since one issue helps the other.

The preceding volume covered five years. Another five year period ends with 1924. The continuance of the index will not interfere with other worthy bibliographical projects, so far as this five year period is concerned, at least. The committee is informed that in anticipation of the association probably desiring to continue with this publication, the indexing can proceed as heretofore.

In view of the importance of the early publication of a work of this character, the committee recommends that it be authorized to make arrangements for the completion of the manuscript early in 1925 along substantially the same lines as in preceding indexes and that the editorial board of the JOURNAL OF ECONOMIC ENTOMOLOGY be authorized, in its discretion, to proceed with the publication of the index and to fix, as heretofore, the price of copies.

Respectfully submitted,

E. P. FELT
A. F. BURGESS
W. E. BRITTON
W. C. O'KANE
W. E. HINDS
Committee

Voted that the report be accepted and the recommendations adopted.

PRESIDENT A. G. RUGGLES: We will now listen to the report of the Committee on U. S. National Museum.

REPORT OF THE COMMITTEE ON NATIONAL MUSEUM

Your committee has maintained its contact with the U. S. National Museum and noted the progress in the work of the Division of Insects, this in spite of the lack of financial support necessary for the proper maintenance of a Museum national in scope.

As a matter of record we note with gratification that the valuable Aldrich Collection of Diptera has been deposited in the Museum by Dr. J. M. Aldrich and that the numerous type specimens in the collection of the Pennsylvania State Department of Agriculture are also being deposited in the Museum. Many institutions and individuals are now regularly placing their type specimens there. It might be noted in this connection that while the Museum, under the present rules, does not lend a unique type, it does lend paratypes and it has always been the rule that any one that deposits type material, even if unique, will have the privilege at any time of borrowing the material which he deposited.

Funds available for publications are wholly inadequate and this committee wishes to go on record as in favor of an enlargement, in the near future, of this important phase of the Museum's activities.

The fact that the National Museum is the principal depository of types in North America and the further fact that this association has encouraged the depositing of collections and types therein makes it desirable that this committee be continued. This will enable our association to more effectively cooperate in the development of this great national collection which has been in the past and will undoubtedly in the future be invaluable to all economic as well as systematic entomologists, since all economic work is based on a correct specific identification.

Respectfully submitted,

J. J. DAVIS, Chairman
HERBERT OSBORN
E. P. FELT
O. A. JOHANNSEN
W. J. HOLLAND
Committee

Voted that the report be accepted.

PRESIDENT A. G. RUGGLES: Next is the report of a special Committee on Amendments to the Constitution and By-Laws.

REPORT OF THE COMMITTEE ON AMENDMENTS TO THE CONSTITUTION AND BY-LAWS

The committee recommends that the classification of the membership in the American Association of Economic Entomologists remain as at present with three classes: Active, Associate and Foreign.

The committee has reached this conclusion after examining replies to all letters on this subject from a number of members of the society. These replies were in a proportion of eight opposed to one in favor of the proposed amendment. No reason

in favor of the proposed amendment was given in any of the letters received advocating this change. The arguments against the proposed changes in membership may be summarized as follows:

1. The proposed classification would be undemocratic and would savor of class distinction.

2. The creation of two new classes of membership would tend to cause jealousies and dissatisfaction.

3. No committee would be competent to divide justly the membership into the proposed classes.

4. The proposed changes would add to the complexity of the meetings.

5. If the new classification should be adopted and prove undesirable it would be difficult to resume a simpler classification.

The committee further recommends that Article 2 of the Constitution be amended by adding "Any member who shall pay to the Association the sum of $100 may be made a life member and shall thereafter be exempt from dues and shall be furnished with the JOURNAL OF ECONOMIC ENTOMOLOGY without further charge."

The committe further recommends that Section 1, Article 3 of the By-Laws be changed to read as follows: "The annual dues of members shall be one dollar and fifty cents, which shall be payable in advance. No dues shall be payable from foreign members. Annual dues shall not include subscription to the JOURNAL OF ECONOMIC ENTOMOLOGY."

The committee further recommends that Article 4, Section 3 of the By-Laws be amended by striking out No. 8 and No. 1 under the subheading "at the following session.", and that the subheadings under Section 3 be renumbered accordingly.

The committee finds on examination of the Constitution that there is a difference between the wording of the Articles on Incorporation and the Constitution and recommends that in the Constitution the name Executive Committee be substituted for the name Board of Directors so as to conform with the Articles of Incorporation.

The committee further recommends that the Secretary be instructed to have the Constitution reprinted.

M. C. TANQUARY
D. M. DELONG
W. P. FLINT
Committee

Voted that the report be accepted.

MR. E. P. FELT: In order that there may be no misunderstanding in regard to the action taken on this report, I think that the changes recommended by the committee in the Constitution and By-Laws should be voted upon separately.

It was voted that this be done and on separate motion, each article was approved by the Association in accordance with recommendations of the committee.

MR. W. E. BRITTON: In view of the fact that we have provided for life membership in the organization, I move that the life membership fees be deposited in the peramnent fund and the income used only in defraying the JOURNAL and Association expenses of life members.

MR. E. D. BALL: After a man dies, we can't make any other use of this money under that provision.

MR. C. L. MARLATT: I think it might be well to provide that this money should go into the permanent capital of the Association. It goes without saying that the interest on this fund, unless it is spent in some other way, goes into the treasury of the Association and in that sense offsets the dues and JOURNAL costs. It isn't necessary to pass a resolution to this effect.

SECRETARY A. F. BURGESS: As I understand the motion, it is simply to give safe method of handling the funds that will come in from life members. If a man takes life membership and pays $100, that $100 will be transferred to the permanent fund and held there so that the income from it could be used to pay his dues and subscription to the JOURNAL during the period of his life.

MR. C. L. MARLATT: I wish to amend the motion to provide that the fees from life members be added to the permanent invested funds of the Association and that the income may be used to meet current Associa-expenses.

MR. W. E. BRITTON: The only objection I see to the amendment is that the income might be used for any expenses of the Association.

It was voted that the motion be passed as amended.

PRESIDENT A. G. RUGGLES: The following committees were appointed some time ago, but I will read the list at this time.

Committee on Resolutions: S. B. Fracker, G. M. Bentley, and R. L. Webster.

Committee on Nominations: J. E. Graf, Leonard Haseman, and J. W. McColloch.

We will now listen to the report of the Special Committee on Sectioning the Association.

REPORT OF COMMITTEE ON SECTIONING THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The growing importance of economic entomology, and the consequent increase in the number of workers, resulting in an increasing number of papers each year to be presented before this Association, has made it advisable to consider means of avoiding the difficulties now encountered because of the crowded program.

Your committee, appointed in September 1923, sent a questionnaire to all of the active members of the Association and the following report is based largely on the replies received.

It does not seem advisable at the present time to create new sections so long as a systematic grouping to permit logical overlapping will accomplish the result desired.

It would seem desirable to use subheadings in the program indicating the group for each session.

It is further suggested that papers be limited to ten minutes, except for important discussions of insects of recognized national importance. Speakers should avoid reading detailed information and limit tabular material. They should present little more than an abstract of the essential points necessary for a clear understanding of the subject. Well-digested, "apparently" extemporaneous statements of three to five minutes should be encouraged, in other words a well-digested "personal" presentation of the subject rather than reading a paper will often enable us to better cover the ground in a minimum amount of time, will afford a good opportunity for useful and interesting discussion and will increase the interest in the meetings. The discussion should not be arbitrarily limited but should be limited at the discretion of the presiding officer to avoid rambling and mere platitudes.

Members were almost unanimous in a desire to retain the present time of holding meetings.

Where grouping and overlapping is necessary,it is suggested that arrangements be made whereby the different groups may be held in the same building. Also, to give members an opportunity to hear papers of special interest, it is desirable that a schedule be established and members must be present in time to present their papers, otherwise they will be read by title and not deferred for presentation later in the session. In this connection, it seems desirable to start meetings promptly regardless of attendance.

Sectional or regional conferences or branches are desirable but in any case they should always be kept subordinate to the mother organization and the meetings held at another time than when the regular Association meetings are held. The qualifications for a branch of the association should be that it include a group of contiguous territory of states or provinces which have somewhat similar problems. It is the opinion of the committee that before the branch is authorized by the association, the entomologists in the territory should present a resolution to the association showing that they had organized in a group and demonstrated by field meetings or otherwise that there is sufficient interest,need, and demand so that a permanent branch is desirable. It is suggested that each branch should have at least one representative attend the annual meeting of the Association each year. It would be desirable for the Association to have one of its officers attend each of the branch meetings annually to maintain closer contact.

Respectfully submitted,
J. J. DAVIS, *Chairman*
A. F. BURGESS
J. A. HYSLOP
G. A. DEAN
Committee

MR. C. L. MARLATT: I am in favor of this report but I would like to have the adoption mean that it is to be put into effect.

MR. WILLIAM MOORE: Isn't there a rule of the Association that papers must be read rather than spoken?

SECRETARY A. F. BURGESS: Papers are supposed to be prepared to cover the length of time that the author requests. If he prefers to give

his remarks verbally within the time rather than submit a paper which would cover no more time than the remarks, I do not see how there could be objection. The recommendation is not contrary to our present practice, except that the time limit on papers is cut from 15 to 10 minutes.

Voted that the report be adopted.

President A. G. Ruggles: Is there any new business?

Mr. D. L. Van Dine: I would like to present a statement in regard to the Association taking an active interest in the Tropical Plant Research Foundation.

STATEMENT CONCERNING THE TROPICAL PLANT RESEARCH FOUNDATION SUBMITTED TO THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS AT THE CINCINNATI MEETING, DECEMBER 31, 1923

Many of our present day necessities are products of the tropics and in the future we will be increasingly dependent upon the crops of the tropical zone. The quantities of sugar and oils, fiber and rubber, coffee and cocoa, fruits and vegetables, that we import annually, are only the vanguard of the future supplies that will be sought within that territory. The production, preparation, and shipment of these products involve many factors in need of research that have as yet received little study. With the exception of the areas under the immediate jurisdiction of this country, the tropical agriculture of the western hemisphere does not have the counterpart of the governmental and institutional agencies which contribute so much to crop production in this country.

The Tropical Plant Research Foundation was organized during the past year under the auspices of the National Research Council and is to be incorporated under the laws of the District of Columbia governing scientific and public welfare organizations. The National Research Council will continue to be represented by a member of the Board of Trustees and will hold the funds of the Foundation. Funds will be received from individuals, firms, corporations, or governments, under written contracts outlining the subjects of research and defining the methods of procedure. Each investigation of a definite problem will be prearranged under a project plan. The money appropriated for one project will not be used for another, except that a specified portion may be expended for the maintenance of the central office of the Foundation. The particular objects of the Foundation are "to promote research . . . of the plants and crops of the tropics, to conduct investigations . . . and to publish the results thereof, and to establish and maintain such temporary or permanent stations and laboratories in the tropical countries as may be necessary for the accomplishment of these objects."

The administration of the Foundation is vested in nine trustees (five scientific and four industrial) who elect their successors. It is the aim of the Foundation to have the scientific trustees represent the several national societies whose scientific field are those with which the purposes of the Foundation are primarily concerned. These societies will be asked to nominate a member of the society to represent the Association on the Board of Trustees of the Foundation. The first societies to be approached in this matter are The American Phytopathological Society and the

American Association of Economic Entomologists. Injurious insects and plant diseases are important subjects in the immediate plans of the Foundation. Because of the importance of rubber in plans before the Foundation for consideration, it is probable that the next national society to be approached will be the American Society of Foresters. Further, it is the intention of the Foundation to become a member of the federation known as the Institute for Research in Tropical America.

At the organization meeting of the Foundation, I accepted an appointment as one of the scientific trustees for a term of one year, pending the presentation of the subject to this Association for consideration. Representing the Board of Trustees and at their direction, I would enlist your interest and active support in this matter and would urge that this request of the Foundation be given favorable action.

D. L. Van Dine,
Scientific Trustee, Tropical Plant Research Foundation

Voted that the statement be referred to the Committee on Policy for its consideration and report at the final business session.

Mr. J. J. Davis: I would like to call the attention of the members to the work of the Thomas Say Foundation. Its purpose is to publish monographs on insects. One volume has been published up to the present time and plans are being made to publish a second volume early in the coming year, and it is hoped that other volumes may appear at rather frequent intervals. The success of these publications depend wholly on the number of volumes that can be sold. Less than 250 copies of Volume I have been sold and only a small percentage of the economic entomologists and a smaller percentage of institutions have purchased the first volume. I want to urge you as individuals to support the Thomas Say Foundation by purchasing the volume issued and by having institutions secure them for their libraries.

Mr. W. E. Hinds: The Southern Entomologists have held a number of meetings under the name of the Association of Southern State Entomologists. The meeting this year will be held at Birmingham, Ala., January 10 to 12. We would like to invite this association to send a representative to that meeting and would be glad to have any of the members attend.

President A. G. Ruggles: This invitation will be passed on to the new President of the Association and I have no doubt that a representative will be appointed.

At the afternoon session the following report by the joint committee on Crown-Gall inspection was read by Mr. H. F. Dietz.

REPORT OF COMMITTEE ON CROWN-GALL INSPECTION

The committee on crown-gall inspection begs to submit the following report:

1. Owing to the wide distribution of *Bacterium tumefaciens,* the large number of

its host plants, and the difficulty of detecting all affected plants, official inspection of nursery stock for the purpose of preventing the dissemination of the crown-gall organism is unwarranted. The sole object of crown-gall inspection is to prevent the sale and planting of stock which will not produce a normal crop. If it be assumed that all plants affected by crown-gall are unfit for planting no method of official inspection is adequate protection for the planter, because of the nature and wide distribution of the causal agent. Inspection regulations should be framed with these things in mind and a clear distinction should be made between crown-gall and malformations due to excessive callousing, cultivation injury, woolly aphis, and nematode injury.

2. The amount of injury done by crown-gall varies greatly with different species of plants and, in some cases, even with different varieties of the same species. Also, it appears to vary somewhat with the character of the soil, methods of culture, and climatic conditions. Accordingly, it is impracticable to have uniform inspection regulations for all kinds of plants or for all parts of the United States.

3. In each State the extent of the injury done by crown-gall to the principal economic plants grown in the State should be accurately determined and the findings used as the basis of inspection regulations. Generally speaking, the persons best qualified to do this are the plant pathologists and horticulturists of the Agricultural College and the Agricultural Experiment Station. They should be consulted freely by those in charge of nursery inspection.

4. In general, the injurious effects of crown-gall have been over-estimated, particularly in the case of the apple. Crown-gall injury is least pronounced in the northern and north-eastern portions of the United States.

5. Crown-gall inspection regulations should describe fully, and as accurately as may be possible, the symptoms shown by plants to be rejected. To say that "all plants visibly affected by crown-gall will be rejected" is not sufficiently explicit. Hair-splitting methods of inspection are unnecessary and should not be permitted. Considerable tolerance should be allowed.

6. Field inspection for crown-gall is unreliable. The only worth-while inspection is that made at the packing shed or at the point of destination.

7. Except as a penalty for law violation, the rejection of an entire shipment because some plants in it are affected by crown-gall is unwarranted.

8. In view of the foregoing it is recommended that this Society solicit the active cooperation of the American Association of Nurserymen in a research program that will ultimately answer the questions now involved, directly and indirectly, in a better understanding of the nursery inspection problems relating to crown-gall.

Respectfully submitted,

F. C. Stewart
M. J. Dorsey
J. E. Mehhus
Harry F. Dietz
Henry B. Chase
Committee

Voted that the report be accepted and that the committee be continued with its present personnel so far as this association is concerned.

At the close of the discussion of the symposium on "Methods of

Estimating Insect Abundance and Damage," it was voted, on Motion of Mr. E. P. Felt, that the chair appoint a committee to standardize methods of estimating insect abundance and damage.

At the Wednesday morning session, at the close of the discussion on the group of papers relating to European Corn Borer, it was voted on motion of Mr. H. A. Gossard that this group of papers be published in the February number of the JOURANL.

FINAL BUSINESS

The final business was transacted Wednesday, January 2, 1924, at 12:20 p. m.

PRESIDENT A. G. RUGGLES: We will now listen to the report of the Committee on Resolutions.

REPORT OF RESOLUTIONS COMMITTEE

1. *Resolved*, That this Association officially endorses the proposal transmitted by the Secretary of Agriculture to the International Institute of Agriculture at Rome as follows:

"The United States suggests that the International Institute of Agriculture change the name of the Bureau now entitled 'Bureau of Agricultural Intelligence and Plant Diseases (Phytopathologie)' to 'Bureau of Agricultural Intelligence and Plant Protection.'"

2. *Resolved*, In view of the renewed interest in the protection of Mississippi valley states against the introduction of the alfalfa weevil and of the recent extensive shipments of alfalfa from the infested areas into those states, this Association recommends to the Federal Horticultural Board an investigation of the practicability of establishing a federal quarantine concerning the alfalfa weevil. (Recommended by a conference of upper Mississippi valley inspection officials on September 13, 1923.)

3. *Resolved*, That this Association express to Dr. J. M. Aldrich the hearty appreciation of economic entomologists for the generous gift of his valuable and extensive collections of Diptera to the United States Museum, and recommends this action as worthy of emulation by the owners of other private entomological collections in the United States, whenever circumstances permit.

4. *Resolved*, That this Association approves the simplification and unification of nursery inspection rulings as outlined by the committee on Unification of Nursery Inspection. Pending the establishment of such a unified system it is recommended that officials of states contemplating quarantines consult with those of other states having similar interests, in order that such rulings may be made uniform.

5. *Resolved*, That in view of the fact that American foulbrood is likely to be introduced into disease free territory in the United States by the shipment of drawn combs, this Association goes on record as favoring the restriction of the shipment of drawn combs, whether or not containing bees, from one state to another in the United States. (Recommended by Section of Apiculture.)

6. *Resolved*, That the American Association of Economic Entomologists express

its appreciation to the authorities of the University of Cincinnati, to the Chamber of Commerce and to the local committee for their courteous hospitality and for their assistance in making this meeting as unqualified success.

G. M. BENTLEY
R. L. WEBSTER
S. B. FRACKER
Committee on Resolutions

Voted that the report be accepted.

PRESIDENT A. G. RUGGLES: The next is the report of the Committee on Membership.

REPORT OF COMMITTEE ON MEMBERSHIP

The committee on membership submits the following report:

1. It recommends for election to associate membership the following list of sixty-four persons:

H. S. Adair
Thomas Armstrong
R. P. Barnhart
Chas. A. Bennett
Curtis Benton
Harry L. Blaisdell
F. W. Boyd
Lloyd W. Brannon
Erle G. Brewer
J. W. Bulger
L. R. Cagle
F. Leslie Campbell
C. F. Greeves Carpenter
Mabel Colcord
Robert P. Colmer
Philip B. Dowden
B. F. Driggers
Frederick L. Fall
Richard Faxon
G. A. Ficht
Stanley E. Flanders
Roger B. Friend
C. F. Galligan
G. Gay
J. U. Gilmore
Alexander A. Granovsky
W. E. Haley
Halbert M. Harris
Reginald Hart
R. D. Hartman
F. C. Hottes
Peter A. Howell
Ray Hutson
Mohammed Kamal
Gordon B. Laing
Harold C. Lewis
Chung Lo Liu
O. C. McBride
R. S. McKay
K. B. McKinney
Robert R. McLean
Joe Milam
John A. Millar
Claud R. Neiswander
Walter Ohlendorf
J. S. Pinckney
Donald T. Ries
William Bobinson
Winford A. Ruffin
Robert L. Shotwell
Joseph C. Silver
Dr. A. G. Smith
L. B. Soliman
Elton S. Stinson
Lee A. Strong
Harvey L. Sweetman
Archie N. Tissot
Frank E. Todd
F. G. C. Tooke
Otis Wade
Arthur B. Wells
Clarke R. Willey
Fred H. Worsinger
H. C. Young

2. The committee recommends for re-instatement to active membership:

Joseph D. Neuls

3. The committee recommends for re-instatement to associate membership:

J. E. Eckert
T. F. McGehee
Vernon R. Haber

4. The committee recommends for foreign membership:

Ivor Tragardh, Experimental Faltet, Stockholm, Sweden

5. The committee recommends the 34 persons whose names follow for transfer from associate to active membership:

O. G. Babcock
W. V. Balduf
B. L. Boyden
F. S. Chamberlin
T. R. Chamberlain
S. C. Chandler
C. L. Corkins
F. C. Craighead
H. L. Dozier
C. H. Gable
C. C. Hamilton
Clifford E. Hood
Stewart Lockwood
P. W. Mason
A. C. Maxson
N. E. McIndoo
F. E. Millen
C. W. Minott
W. J. Nolan
Wallace Park
D. C. Parman
H. B. Peirson
H. K. Plank
S. A. Rohwer
G. A. Runner
E. E. Scholl
E. Graywood Smyth
E. W. Stafford
C. F. Stahl
Arnold P. Sturtevant
A. F. Swain
E. P. Van Duzee
F. M. Wadley
Claude Wakeland

6. The committee recommends that the resignation of the following members be accepted:

C. F. Baker
Parker T. Barnes
T. H. Cutrer
R. J. Fiske
A. B. Gahan
E. J. Hoddy
Herman Lancaster
F. L. Washburn
H. R. Watts

7. Lastly, the committee recommends that the 7 active and 24 associate members who are now in arrears for dues for two years, be notified that if these dues are not paid within a reasonable length of time, that the Secretary be instructed to drop the names of these members from the roster of this association.

Respectfully submitted,
J. S. HOUSER
G. G. AINSLIE
W. E. BRITTON
Committee

It was voted that the report be accepted and the recommendations adopted.

The Committee on Policy presented the following report relative to the Tropical Plant Research Foundation.

The Committee on Policy endorses the purposes and objects of the Tropical Plant Research Foundation and recommends that the association elect a member to serve on the Board of Trustees of the Foundation for a period of three years.

Voted that the report be accepted and the recommendation adopted.

PRESIDENT A. G. RUGGLES: The next report is the nomination of the JOURNAL officers by the Advisory Committee.

REPORT OF ADVISORY BOARD JOURNAL OF ECONOMIC ENTOMOLOGY

Your Advisory Board begs to recommend that the present officers of the JOURNAL OF ECONOMIC ENTOMOLOGY be continued in office, as follows:

Editor, E. P. Felt.

Associate Editor, W. E. Britton

Business Manager, A. F. Burgess.

The Board desires also to express on behalf of the Association of Economic Ento-

mologists the appreciation not only of the membership but of all entomologists of the efficient work of the present JOURNAL officers.

E. F. PHILLIPS
ARTHUR GIBSON
R. A. COOLEY
H. A. GOSSARD
Members Advisory Board

Voted that the report be accepted and the recommendations adopted.

PRESIDENT A. G. RUGGLES: The report of the Committee on Nominations will now be read.

REPORT OF THE COMMITTEE ON NOMINATIONS

Your Committee on Nominations begs to report as follows:

President, A. F. Burgess
1st Vice-President, M. C. Tanquary.
2nd Vice-President, H. S. Smith.
3rd Vice-President, E. R. Sasscer.
4th Vice-President, R. W. Harned.
Secretary, C. W. Collins.
Committee on Policy, A. G. Ruggles.
Committee on Membership, W. P. Flint.
Advisory Board, JOURNAL OF ECONOMIC ENTOMOLOGY, A. C. Baker, E. N. Cory.
Committee on U. S. National Museum, W. E. Hinds.
Representative to National Research Council, G. A. Dean.
Councillors for the American Association for the Advancement of Science, T. J. Headlee, L. O. Howard.
Trustee for Crop Protection Institute, W. C. O'Kane.
Representative on Council of Union of American Biological Societies, A. L. Quaintance, C. R. Crosby.
Representative on Board of Trustees of the Tropical Plant Research Foundation, D. L. Van Dine.

Respectfully submitted,
J. W. MCCOLLOCH
L. HASEMAN
J. E. GRAF, Chairman
Committee

MR. W. E. BRITTON: If any man deserves the honor of being elected President of this Association on account of long, faithful service, that man is A. F. Burgess.

It has been customary to authorize the Secretary to cast the ballot for the election of these officers. Knowing that Mr. Burgess is a very modest man, and wishing to relieve him of having to cast a ballot for his own election, I move you the stenographer be authorized to cast the ballot.

PRESIDENT A. G. RUGGLES: Those in favor of such a motion will rise.

. . . The members arose . . .

PRESIDENT A. G. RUGGLES: It is unanimous. The new officers are elected.

It gives me great pleasure to hand this honorable weapon to my worthy successor, Mr. Burgess.

PRESIDENT-ELECT BURGESS: Members of the Association: I am not in the habit of using a gavel or a mallet, or a hammer, so I will merely say that I will try to use this in a way that will meet with your approval during the coming year.

The office of President of this Association is the highest one that can be conferred upon any member. I certainly appreciate the action which you have taken, and I appreciate the support and help and good fellowship that has existed between the members of the Association and myself during the years that I have been officially connected with this organization. It goes without saying, and you all know that I have been interested in this organization and its success, and if there is anything I can do officially or otherwise during the coming year to make it more effective, I shall do it to the best of my ability.

We are not a small group of isolated workers as we used to be years ago, we are becoming a large and important organization in our chosen line, and the influence of the organization extends not only to the workers in this country, but throughout the world. It is a great honor to serve you in this capacity, and I thank you all.

PRESIDENT A. F. BURGESS: Is there any miscellaneous business?

MR. J. J. DAVIS: You are all familiar with the attempt that is being made to sell the Barnes collection of Lepidoptera to the U. S. National Museum. The Entomological Society of America has appointed a committe to investigate the matter and to report on the desirability, the value, and need of this collection. I would like to move that the President appoint a committee of three to work with the committee of the other society to investigate the propaganda being circulated about the sale of the William Barnes collection and to formulate a complete report within 30 days and that a copy of this report be submitted to the Secretary of the U. S. National Museum, the Secretary of the U. S. Department of Agriculture and the Chief of the Bureau of Entomology.

MR. E. P. FELT: I have no objection to the proposed action, but an attempt to formulate a report of this sort might embarass the committee and I am not altogether clear that it is advisable for committees in both organizations to handle the same matter. This seems to be within the province of the Entomological Society of America and as our membership

is to a large extent duplicated in both, I think it would be better to take no action.

Mr. J. J. Davis: The reason why this matter should be considered by the economic entomologists is the fact that the reasons for the sale of the collection are based on its economic value.

The motion was carried.

Mr. L. O. Howard: I wish to move that it is the sentiment of this association to present to the retiring President its very hearty thanks for the tact, courtesy and efficiency with which he has presided over this meeting.

The motion was carried.

Mr. W. E. Britton: I would like to suggest that the local committee secure copies of the radio messages that were received at the entomologists' dinner, have them mimeographed, and sent to the members.

It was voted that the committee be requested to do this.

On motion, it was voted that the time and place of the next annual meeing be left to the Executive Committee.

As there was no further business, the meeting adjourned at 1:00 p. m.

PART II. ADDRESSES, PAPERS AND DISCUSSIONS

Morning Session, Monday, December 31, 1923

At the close of the business session, President Ruggles called upon First Vice-President Gossard to preside.

Vice-President Gossard: We will now listen to the Annual Address of the President.

PIONEERING IN ECONOMIC ENTOMOLOGY[1]

By A. G. Ruggles, *St. Paul, Minn.*

Abstract

Economic Entomologists as scientists should be moderate, not radical.

The economic entomologist has evolved from the systematic and morphological entomologist.

The most promising field of endeavor for the economic entomologist today is in the field of ecology. To be equipped for this, broad and deep fundamental training in the sciences is absolutely necessary.

In every great movement whether political, religious or scientific, ideas seem to swing from one extreme to the other. For the general run of people there seems to be no middle ground. They must be either extremely radical or extremely conservative. My plea at this time is

[1]Published with the Approval of the Director as Paper No. *446* of the Journal Series of the Minnesota Agricultural Experiment Station.

that we as scientists should not be too impulsive. We should be deliberate and not change radically until all the scientific facts are brought out and marshalled in evidence. We should not be too hasty to change nor so conservative that we can not change when the truth comes.

The subject that I have chosen for my address is very similar to subjects used by former presidents of this association but one that I think will best express some of the ideas that have been formulating in my mind for a number of years. I trust I can present them in the way I feel them.

I am particularly interested in the younger entomologists. I should like to have them get a vision beyond the things we are doing in economic entomology today and see what a tremendous realm our favorite science occupies in the affairs of men, offering wonderful opportunities for study, recreation and thought. Many of us have to do missionary work of the simplest type in entomology. Someone has to do it and we do it gladly if only the younger men will appreciate and profit by what has been done for them in the making way for the bigger things that they are to do.

The thesis I wish to develop at this time is that there has been a gradual process of development to produce the economic entomologist. The first real economic entomologists were predominantly morphological and systematic entomologists. Then the importance of injurious forms becoming more apparent, the entomologists became more and more economic entomologists and less morphologists and systematists, until today the economic entomologist accepts everything he can use from the morphologist, the systematist, the biologist, the chemist, the physicist, the physiologist, and particularly that new man, the ecologist, an "ist" using these and all other combinations. The wonderful strides made in the last few years where the combination is working the strongest shows what cooperation and coordination can do, and in all this wonderful development of our science I believe we are still in the pioneer stage. I believe we are just on the verge of great developments in economic entomology.

Before passing on to the development of my thesis I should like to take a little time to mention briefly the pioneers in entomology. Many of the older biologists worked with other animals as well as with insects. Often these men were nothing but compilers, observers or philosophers, yet all exerted a certain amount of influence on future thought and work. All of these men who in any way influenced the study of entomology, which is the foundation study of economic entomology,

should be mentioned if a complete history of our science is to be given. To give a complete or anywhere near a complete list is entirely too large an undertaking for such a short paper as this. Therefore only a few of the more striking personalities will be mentioned.

As one of our great teachers, Oestlund, puts it, "the development of science follows the development of commerce and the gaining of riches. Then under a stable and strong government, science flourishes along with art, literature, and architecture and usually in educational centers."

It will be seen that this is true for we have in succession bright lights in Greece, Rome, Italy, The Netherlands, Germany, Scandinavia, France, England, and finally America. At certain stages great men have arisen in each of these centers.

Undoubtedly there were great scientists in Egypt and probably good entomologists. That they knew something of insects we gather from Moses. He mentions tryxalines, crickets, locusts, etc. In the original Hebrew several species of locusts are mentioned for which the English translators had only the one word "locust."

Solomon was another of the Hebrews in contact with Egyptian civilization who knew considerable about the habits of insects.

In ancient Greece the outstanding name is Aristotle (384–322 B.C.). He with his philosophy on the structure and development of animals was, as one writer says, the forerunner of the morphologist. He put considerable thought on the classification of animals and mentioned nearly 50 insects.

In ancient Rome, Pliny (23–79 A. D.) was the great compiler but really added nothing to previous knowledge. He did much, however, to classify and to make popular.

Passing thru the Middle Ages we come to Aldrovandi (1522–1607) in Italy. His principal work added much to the classification and general knowledge of insects. Redi (1626–1697) with his work on flesh flies took up the study from the experimental standpoint and put the theory of spontaneous generation into the discard. Malpighi (1628–1694) made wonderful advances in studies on the internal structure of insects.

In the Netherlands Swammerdam (1637–1685) with his Bible of Nature became the true founder of structural entomology. He also worked on the metamorphosis of insects.

In Germany, Gesner (1516–1565) "the modern Pliny" was a bright light. He was one of the greatest of compilers. Germany later produced entomologists like Burmeister (1807–1892), Graber (1844–1892), and Ratzeburg (1801–1871).

In Scandanavia. Linnaeus (1707–1778) was produced. Upon his 10th edition, 1758, of Systema Naturae all modern classification is based. We know that Linnaeus was one of the greatest of economic entomologists. Not only did he save the insect infested timber of the Swedish king by suggesting that it be immersed in water but he was sent to different parts of Sweden to make economic studies on various subjects. Insects of economic importance are often discussed in his reports.

In the next great center, France, perhaps Latreille (1762–1833) was the outstanding figure. His contribution to the classification of insects was so correct from our standpoint that much of it stands at the present day. Reamur (1683–1757) made very careful and painstaking studies on the habits and metamorphoses of insects. The name of Cuvier (1769–1832), the founder of comparative anatomy, occupies a prominent place in biology. Lamarck (1744–1829) was another notable figure in the world of classification at that time.

In England perhaps the culmination of scientific endeavor came in Darwin (1809–1882) whom we can consider the first great ecologist. Of the English entomologists of last century probably Kirby (1759–1850), Spence (1783–1860), Newman, E. (1801–1876), often considered the first economic entomologist, Westwood (1805–1893), and Sharp (1840–1922) are outstanding.

In America, the last great center, it remains for the future to determine the name of the outstanding example of greatness in biology.

As this is the 75th anniversary of the A. A. A. S. it is fitting that we take a little time and see who the entomologists were who were on the stage in 1848 when the A. A. A. S. was founded. Here we will find men who were the founders or the real pioneers of economic entomology in America. W. D. Peck (1756–1820) and Thomas Say (1787–1834) had already passed off the stage.

Louis Agassiz (1807–1873) was 41 years of age at that time. We usually do not think of him as an entomologist. Nevertheless he made some remarkable contributions to our smaller field in zoology.

Ebenezer Emmons (1799–1863) was at that time 49 years old;
Asa Fitch (1809–1879) was at that time 39;
S. S. Haldeman (1812–1880) was 36;
T. W. Harris (1795–1856) was at that time 53;
J. L. LeConte (1824–1883) was 24, and
F. E. Melsheimer (1782–1873) was at that time 66 years old.

These seven men were all enrolled on the membership list of the A. A. A. S., in 1848, where the total number is 461. On this list I also

find other charter members of the A. A. A. S., whose bibliographies show that they had a special interest in economic entomology. These are Walter I. Burnett of Boston, F. P. Buckley of New York, E. C. Herrick (1811–1862) of New Haven, Conn., C. Hildreth of Marietta, Ohio, C. P. Jackson of Boston, and J. P. Kirtland of Cleveland, Ohio.

Those old enough to belong to the Association at that time but either not in this country or not yet having had the opportunity to join the association were, Wm. LeBaron (1814–1876) who was at that time 34 years of age; Townend Glover (1813–1883) who was 35; H. A. Hagen (1817–1893) who was 31; Joseph Leidy (1823–1891) who was 25; J. A. Lintner (1822–1898) who was then 26; C. R. Osten Sacken (1828–1906) who was only 20; Henry Shimer (1828–1895) who was also only 20; Cyrus Thomas (1825-1910) who was 23, and B. D. Walsh (1808–1869) who was at that time 40 years of age. All of these were on the stage and had probably started their work in entomology.

It will be interesting to note also those entomologists who were just coming on the stage. Two of this number we have with us today, namely C. J. S. Bethune (1838–), and S. A. Forbes (1844–). A. J. Cook (1842–1916) was then 6; C. H. Fernald (1838–1921) was then 10; A. R. Grote (1841–1903) was then 7; Otto Lugger (1844–1901) was then only 4; A. S. Packard (1839–1905) was then 9; Theodore Pergande (1840–1916) was then 8 years of age; C. V. Riley (1843–1895) was then only 5; Wm. Saunders (1835–1914) was then 13; S. H. Scudder (1837–1911) was then 11; F. H. Snow (1840–1908) was then only 8, and P. R. Uhler (1835–1913) was then 13 years old.

Of those who have come upon the stage in entomology since and have passed on we have such never-to-be-forgotten names as W. H. Ashmead (1855–1908), D. W. Coquillet (1856–1911), James Fletcher (1852–1908), C. G. Hewitt (1885–1920), H. G. Hubbard (1850–1899), G. W. Kirkaldy (1873–1910), M. V. Slingerland (1864–1909), J. B. Smith (1858–1912), F. M. Webster (1849–1916), S. W. Williston (1852–1918), and without question a number of others whom I have overlooked. But these are undoubtedly some of our most valuable workers in entomology lost by death in comparatively recent years.

Fortunately many excellent workers such as Britton, Bruner, Comstock, Gillette, Felt, Forbes, Howard, Oestlund, Osborn and Schwarz, are still here to carry on and inspire the younger generation in economic entomology.

As previously mentioned Linnaeus was probably the first scientific economic entomologist. From his time on it will be seen that the ento-

mologist whether systematist or morphologist as long as he was identified with entomology was called more and more into consultation on problems relating to insects of economic importance. This was because he was the only entomologist of any kind to be consulted. More and more this type of man was called upon until the gradual evolution of the economic entomologist was attained.

In this country Harris was undoubtedly the first real economic entomologist. His interests primarily were with economic forms. His writings abound with excellent observations on the insect under consideration and with sound practical common sense methods of control. His style has been followed by many workers who came after him, all being imbued with the idea of producing as Fernald called it "the rational methods of insect control," that is, methods based on the knowledge of the life history of the species under consideration. The man with the most ingenuity in devising schemes of destruction obtained the public applause and gratitude. A further step in the study came when still more attention was paid to the details of the life history of the insect. The more complete the knowledge of the life history, the more facts were obtained upon which to base an appropriate method of control. Thus with insecticides coming more and more into use the insect could be struck at a vulnerable point culminating in its subjection. The "biological age" as Dr. Howard calls it is very applicable to this period. A great many papers could be cited to illustrate this method but perhaps the best are those by the late Professor Slingerland. These were marvels of accuracy and acumen in giving details hitherto not known.

The use of insecticides has led to a side issue that has assumed enormous proportions. Many of the later entomologists even before thoroughly studying the life of the insect began experimenting with insecticides for the control of the insect in question. An enormous field has opened up here for the entomologist but it must of necessity be primarily a chemistry field. It is not well for the entomologist to lose sight of the insect. The insect is primary not secondary. Not all insects can be controlled by insecticides and the sooner we learn that fact the better. In experimenting with insecticides often one experimenter will get a result diametrically opposed to another worker in another state. The reason evidently is that the factors which enter into the problem have not all been taken into consideration. Temperature, moisture, wind velocity and probably a number of other factors have not

been correlated and until all the factors are correlated no definite rules of application can be applied.

While this great phase had been going on in the sideline of chemical development other entomologists had already begun the control study from another angle. This study to be sure had been going on for decades but a greater impetus seems to have been given to it during the last 15 years. This is a control based on the ecological study of insects in the broadest sense of the term. The three steps then in the progress of development may be compared to a great tree,—the trunk and roots being the morphological and the systematic, the larger limbs being the biological aspects and the smaller branches and the tips of the twigs being the grasping of the relationships of the insects to their environment.

Perhaps the first publications where this approach was appreciated were those by our own Dr. S. A. Forbes. A few of the other more important papers along these broader ecological lines are those of Hopkins, with his bioclimatic law and with his host selection principle as proved by Craighead; those of Headlee on temperature and humidity on insect metabolism; Shelford in his studies of environmental factors; Pierce on death rate and climatic condition; Sanderson on the influence of minimum temperatures in limiting distribution; Peairs on the relation of temperature to insect development; Craighead with his manipulation of shade for the control of the locust borer; Chapman in his granary weevil work and a host of others. McColloch and Hayes in their studies of "soil temperature and its influence on white grub activities" are likely to get some interesting leads in combating injurious soil insects. Newell and Smith in the so-called "Florida method" of boll weevil control have taken advantage of a knowledge of the ecology of the boll weevil in making more effective the use of insecticides. These and many other ecological studies offer uncommonly interesting material for the present day entomologist to follow. The lead seems to be a good one and may take us into newer and certainly wider fields. The paper of J. DeWitz in the Bulletin of Entomological Research (1912) on "The Bearing of Physiology on Economic Entomology" and the wonderfully interesting address of the late Dr. Hewitt to this Association in December 1916 on Insect Behavior show many of the reactions I have in mind.

Today there are insects doing a tremendous amount of injury that we say cannot be controlled. Some entomologists have even given up the hope of ever controlling these insects. I believe that someone here today

will find in the near future very simple combative measures for these today difficult problems. The specialist in entomology alone will not do it, the chemist will not do it, the physicist will not do it, but the man with the training in the fundamentals, with the grasp of the essentials of the different branches of our entomological tree, a knowledge of the twigs at the ends of these branches, will so correlate the relationship or manipulate the factors that we will be surprised at the simplicity of the control. C. H. Fernald in his address to the Association in August 1896 brought out the fact that the chemist and the physiologist must come to the aid of the economic entomologist. The point I wish to bring out is that these and many more branches of science have already come to the aid of the economic entomologist and that the more "ists" that come the better. To the younger generation if it has the proper foundation to build on, the field is unlimited. We have just begun to study. We are still pioneering but I believe we are on the right road.

The session adjourned at 12:25 p. m.

Afternoon Session, Monday, December 31, 1923

The afternoon session convened at 1:30 o'clock, President Ruggles presiding.

PRESIDENT A. G. RUGGLES: The first paper is by Perez Simmons.

BIOLOGY OF THE ANGOUMOIS GRAIN MOTH—PROGRESS REPORT

By PEREZ SIMMONS, *Assistant Entomologist*, and GEORGE W. ELLINGTON, *Junior Entomologist, Stored Product Insect Investigations, Bureau of Entomology*

SUMMARY

Certain new facts regarding the biology of the Angoumois grain moth, *Sitotroga cerealella* Oliv., are included in the present report. A life cycle of about 5 weeks in hot weather when infesting newly-harvested wheat is indicated. As many as 283 eggs may be laid. The sexes occur in nearly equal numbers, males being slightly more numerous than females. Under certain conditions the availability of drinking water affects the egg-laying powers of the females.

The Angoumois grain moth (*Sitotroga cerealella* Oliv.) has recently been responsible for heavy losses among wheat growers, particularly those situated in the Atlantic coast wheat-growing area, which lies in Pennsylvania, New Jersey, Delaware, Maryland, Virginia, and North Carolina. The infestation of the 1922 crop was unusually severe, and in order more thoroughly to understand the causes and control of such

outbreaks, the writers were assigned to an investigation of the biology of the insect. The present paper is a brief report of the progress of this investigation, which is being carried on at a field laboratory near Silver Spring, Maryland, a suburb of Washington.

As is well known, the Angoumois grain moth is a cereal pest of long standing both in Europe and in the United States. It is now distributed widely over the world. Since 1736 the insect has claimed the attention of French entomologists, beginning with the famous Réaumur, and in 1760 it caused such great damage in the now obsolete province of Angoumois (which included a region near the west coast and north of Bordeaux) that an appeal was made to the government for aid. There followed an exhaustive study of the pest by Duhamel and Tillet, two members of the Paris Academy of Sciences. They published in 1762 an illustrated report of more than 300 pages, one of the outstanding early contributions to the literature of economic entomology. These investigators recorded the important fact that standing grain is infested by moths which emerge from stored grain and fly to the fields where oviposition takes place on the developing wheat.

In this country infestation evidently first became noticeable in North Carolina, about 1728. Numerous accounts of the insect have since appeared here, but a detailed study of some phases of its life history has not been made. The influences which affect the rate of increase should be understood as far as possible, and the present report refers to some of these factors.

The fecundity of the moth appears to have been underestimated by other workers. Duhamel and Tillet recorded 60 to 90 eggs as the production of the female. King's work in Pennsylvania in 1917 resulted in egg records up to 146 eggs. Selected records given in Table 1 show that totals of more than 200 eggs are not uncommon, while a few moths deposit nearly 300.

The females do not require the presence of grain as a stimulant to abundant oviposition. When females confined in vials are provided with two pieces of cardboard held rather tightly together with a paper clip, they usually deposit all of their eggs in the crevice between the cardboard strips, the eggs being glued in place in large clusters. Drinking water was given to many of the pairs and this was taken eagerly through the uncoiled proboscis. The average number of eggs laid by 81 females thus treated was 133, the individual records ranging from zero to 283.

The moths mate promptly after emergence and remain in copula for a

TABLE I. OVIPOSITION OF SELECTED FEMALES OF THE ANGOUMOIS GRAIN MOTH (*Sitotroga cerealella* OLIV.) (Silver Spring, Md.—1923).

Pair No.	Emerged and mated	Oviposition on Day Number 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total Eggs
1	Aug. 26	110	33	24	16	11	10															204
8	" 26			104	20	12	27	8	4	9	7	0	8	2								201
27	" 29	40	15	58	36	22	18	21	16													226
34	Sept. 5	51	0	126	0	43	25	16	14	0	0	6	0	2								283
38	" 6		43	0	49	16	34	36	11	0	1	16										206
46	" 12	46	76	0	0	0	34	18	16	6	16	0	15									227
48	" 12		32	0	9	4	44	23	26	0	23	0	11	15	6	10						203
75	" 24		96	37	0	20	0	10	7	8	4	0	29									211
82	" 27			45	26	35	3	41	10	16	8	0	4	3	7	3						201
84	Oct. 2	17	83	10	21	41	9	21	0	15	10	7	6	9	3	2	7	0	0	0	2	263
113	Nov. 14					42	32	0	65	0	45	0	13	19	7	10	10	7	13	12	6	281

Note: All pairs except Nos. 1 and 8 given water.

TABLE II. SUMMARY OF OVIPOSITION OF THE ANGOUMOIS GRAIN MOTH (*Sitotroga cerealella Oliv.*), SHOWING EFFECT OF PROVIDING DRINKING WATER (Silver Spring, Md.—1923)

Emerged and Mated	Total Eggs	Remarks
Aug. 26	196	no water
26	196	" "
26	159	" "
26	157	" "
26	201	" "
26	122	given water
26	132	" "
26	123	" "
26	107	" "
26	131	" "
Sept. 21	0	no water
21	133	" "
21	22	" "
21	30	" "
19	170	given water
19	134	" "
19	139	" "
19	144	" "
Oct. 2	0	no water
2	0	" "
2	71	" "
2	77	" "
2	0	" "
2	263	given water
2	169	" "
2	44	" "
Nov. 14	19	no water
14	2	" "
14	0	" "
14	0	" "
14	281	given water
14	113	" "
14	164	" "
14	142	" "

considerable period, not infrequently as long as 2 or 3 hours. Copulation occurs more than once. In hot weather the preoviposition period is less than 24 hours. The incubation period is as short as 4 days. During August and September the incubation periods of 13,000 eggs varied from 4 to 10 days in length. The duration of the period from hatching to emergence was as short as 28 days, in new-crop wheat.

These records indicate a possible minimum life cycle of a little less than 5 weeks.

In cultures begun about the middle of September with wheat harvested early in July the usual minimum period from oviposition to emergence was about 6 weeks. These trials were made in a laboratory kept at living-room temperatures (70 to 80° F.) during the day, with unfavorable temperatures often obtaining at night.

The rapidity of development of larvae from eggs laid the same day varies considerably. Emergence from eggs laid in August and the first 3 weeks in September continued, in each case, over a period of about a month. During the early part of such emergence the males are the more numerous, while near the end the females predominate.

The sexes occur in nearly equal numbers. Of 6,263 individuals the developmental periods of which were recorded, 51.2% were males and 49.8% were females. The adults have been observed to live for over a month, with a maximum longevity of 38 days. Records of 112 mated pairs show an average longevity for the males of 12.38 days and for the females 13.61 days.

Table II shows the results of observations on parallel series of mated pairs, some of which were provided with drinking water. In the fall months the pairs which had water were much the more prolific. Plentiful egg-laying obviously makes heavy demands upon the bodily moisture of a female. Further experiments are required to decide the relation to fecundity of the moisture content of the grain during immature life and of the air humidity during adult life, in the absence of a supply of drinking water.

PRESIDENT A. G. RUGGLES: A paper will now be presented by T. H. Jones and W. G. Bradley. It will be read by Mr. Bradley.

FURTHER OBSERVATIONS ON TABANIDAE (HORSEFLIES) IN LOUISIANA

By THOS. H. JONES and W. G. BRADLEY, *Experiment Stations, Louisiana State University, Baton Rouge, La.*

ABSTRACT

The observations here given in brief supplement the reports of Professor J. S. Hine and the authors on the Tabanidae or horseflies of Louisiana. One additional species has been taken as adult and the larvae of nine species, which had not been previously taken in this stage, have been collected in the field. Notes on the time of year when adults of various species were taken in the vicinity of Baton Rouge during

1922 and 1923 are given, as well as a brief statement as to the species that were observed to be of most importance as pests of livestock in this locality.

During 1920 the Tabanidae of Louisiana were made the subject of a project of the Louisiana Experiment Stations. In the June, 1923, number of the JOURNAL OF ECONOMIC ENTOMOLOGY we gave a resumé of the progress of this project up to the end of 1922, insofar as observations made supplemented what has been published by Professor J. S. Hine, who made a study of the horseflies of the State during 1905 and 1906. (See Circular No. 6 of the Louisiana State Crop Pest Commission and Bulletin No. 93 of the Louisiana Agricultural Experiment Station).

It is our purpose to here record briefly, and in a similar manner, observations made during 1923.

In our previous paper we added the names of 14 species to the 40 species of Tabanidae that Professor Hine recorded as occurring in Louisiana. Only one additional species, which has been determined by Professor Hine, can now be added. This is *Tabanus nefarius* Hine, a single female of which was taken at Reserve on August 31.

NOTES ON IMMATURE STAGES

Since the project was begun in 1920 adults of 4 species of the genus Chrysops and 15 species of the genus Tabanus have been reared from larvae collected in the field. Several species that, as adults, have been noted to be common about livestock have not yet been taken in the larval stage.

In our previous paper we referred to 10 species that had been reared from larvae. While additional adults of some of these have been reared during 1923, only the collecting and rearing of the remaining 9 species need be considered at present. The larvae of these 9 species have been taken in water or in close proximity to it. During the year more attention has been given to drier areas in searching for the immature stages than was previously the case, but we still appreciate the fact that such areas should be more thoroughly examined, as well as bodies of water differing in type and surroundings from those to which we have so far given most of our attention.

In our rearing work we have continued to keep larvae in moist sand in small glass jars in a well-ventilated insectary. Only one larva is placed in a jar and earthworms are provided as food. Professor Hine has very kindly determined for us several adults that have been reared or collected in the field during 1923.

Chrysops obsoletus Wd. A larva and a pupa of this species were found in mud beside a shallow, slowly-flowing brook in a small clearing in woods at Magnolia on May 8, 1923. The ground along the edge of this brook was swampy and covered with an abundant growth of water-plants. The larva pupated in confinement without having received food and a female adult issued on May 28. The pupa produced a male adult on May 15.

Chrysops pikei Whit. A single larva of this species was taken at Magnolia on January 4, 1923, in mud at the edge of a pool of stagnant water in a depression in a wooded area. The character of the flora in and around the pool indicated that water was present in the depression throughout the year. The pupa was found on March 13 and on April 2 a male adult issued.

Tabanus americanus Forst. Three larvae were taken from mud at the edge of a shallow pool of stagnant water in East Baton Rouge Parish on January 10, 1923. In this pool, and on a limited area around its edge, there was a heavy growth of hardwood trees and some cypress, with a dense undergrowth of rushes and switch cane. Other smaller aquatic plants were present, indicating that the pool was more or less permanent. The area was entirely surrounded by cultivated land, although the outer edge of an extensive swamp was only about 200 yards distant in one direction.

The pupa of one of these larvae was found on May 29 and a male adult issued on June 2. Another pupa was found on June 12 and on June 16 a male adult issued. The third pupa was found on August 6 and the adult, also a male, issued on August 16.

Tabanus benedictus Whit. Two small larvae were taken on December 29, 1922, in East Baton Rouge Parish from mud along the edge of shallow, stagnant water in a slough about 100 yards long and about 12 feet in greatest width. There was not much vegetation growing on the margin of the slough, or in it, possibly due to the frequent flooding to which the locality is subjected. The pupae of the two larvae were found on June 18. One adult female issued on June 27 and another on July 1.

Tabanus cymatophorus O. S. One larva was taken from mud at the edge of a small, shallow, stagnant pool in woods at Magnolia on July 12, 1923. The pupa was found on August 14 and a male adult issued on August 19.

Tabanus lineola Fab. Of 24 larvae of this species, reared to the adult stage in confinement, 22 were found in mud around pools of stag-

nant water in open country. The other two were taken from mud at the edge of stagnant pools in woods. Since the greater part of our search for tabanid larvae has been confined to wooded areas it appears that pools in more or less open areas are the preferred breeding places of this species. All larvae were collected on various dates during December, 1922, and January, 1923. Adults appeared between April 28 and May 15, 1923; 16 of them being males and 8 females. Observations made indicated that the length of the pupal stage varied from 10 to 16 days.

Tabanus melanocerus Wd. A single larva was collected at Magnolia on September 12, 1922, from the slimy mud at the edge of a swift flowing stream, the height of which varies considerably during the year. A wide sand bar formed the bank of the river at the point where the larva was found and this bar was free of vegetation. The finding of the larva in such a situation does not, of course, necessarily indicate that this is a natural breeding place for the species, since the larva may have been washed down from a point higher up.

The larva did not feed between the end of January and the first of April and no food was taken after May 1. The pupa was found on May 21 and an adult male issued on June 1.

Tabanus mexicanus L. Larvae were found in mud at the edge of stagnant water in a brook bed and in a hole formed by an uprooted tree in wooded areas in East Baton Rouge Parish during September and December, 1922. Five larvae were received on September 24, 1922, from Mr. G. H. Bradley of the U. S. Bureau of Entomology, who is stationed at Mound, La., where the Bureau maintains a laboratory for investigations having to do with mosquitoes. Mr. Bradley's note in regard to the finding of these larvae is as follows:—"Five small larvae taken on surface of lake station 56A. Location; shady. Water 2 to 24 inches deep. Surface; covered more or less with duckweed. Margin; bare of grass, soft, and covered with decaying vegetation. Bottom; muddy, very soft." Adults issued on various dates from the middle of May to the first of August, the length of the pupal stage ranging from 9 to 16 days. A single larva, apparently of *mexicanus*, was still alive and in good condition on December 1, 1923.

Tabanus venustus O. S. A single larva was collected from mud at the edge of a small brook on March 14, 1923, in East Baton Rouge Parish. At the time the larva was found the brook, which at this point flows between high, steep banks through an open, rolling field, was about one foot in width and very shallow. There was a growth of small water

plants along the brook where the larva was taken. Pupation took place during the week of July 23 and a female adult issued on August 2.

The larvae of two species of tabanids have been taken in the vicinity of Baton Rouge under somewhat interesting circumstances. Through the removal of large quantities of earth for dike building purposes during the last of April and the first of May, 1922, and the subsequent filling of this excavation with water, a rather extensive pool was formed in an area which had previously been comparatively high ground. Wild grasses, rushes, and other aquatic plants later grew up in the pool and during the winter and spring of 1923 larvae of *Chrysops flavidus* Wd. were found in large numbers in the mud at the edge of the water and about the submerged bases of grass stools. Larvae of *Tabanus lineola* Fab. were also common along the edge of the water. These larvae, with the exception of those which died, were reared to adults before September, 1923. This strongly indicates that the life-cycle of the two species normally extends over at least no more than one year.

Notes on Adults

Field observations have been continued in the vicinity of Baton Rouge for the purpose of ascertaining when the adults of various tabanids occur in this section and the relative importance of the various species, especially as pests of livestock. In making these observations collections have been made from time to time from horses, mules, and cattle, as well as about man, in areas where horseflies are most abundant. (The following table gives, in a brief way, information of this nature that has been obtained during 1922 and 1923.)

Seasonal Occurrence of Adult Tabanids in the Vicinity of Baton Rouge as Indicated by Collections Made During 1922 and 1923

Species	Months in which adults were taken.	Period of greatest abundance
Chrysops callidus O. S.	April, May, June	April
" *flavidus* Wied.	April, May, June, July, August September, October	April and May
" *fulvistigma* Hine	May	———
" *montanus* O. S.	May	———
" *obsoletus* Wied.	May, June, July, August, September, October	June
" *pikei* Whit.	April, May, June, August, October	April
" *seperatus* Hine	April	———
" *vittatus* Wied.	April, May, June, July, August, September, October	June and September

Tabanus	*abdominalis* Fab.	June, July	Never common
"	*aequalis* Hine	May, June, July	June
"	*americanus* Forst.	May, June, July, August	Never common
"	*annulatus* Say	May, June, July, August	Never common
"	*atratus* Fabr.	April, May, June, July, August, September, October	Never common
"	*benedictus* Whit.	June, July, August, September	August
"	*cerastes* O. S.	May	———
"	*costalis* Wied.	April, May, June, August, September	August
"	*cymatophorus* O. S.	July, August	Never common
"	*exul* O. S.	September	———
"	*fulvulus* Wied.	May, June, July	May
"	*fuscicostatus* Hine	May, June, July August	June
"	*giganteus* DeG.	July, August, October	August
"	*lasiophthalmus* Macq.	March	———
"	*lineola* Fab.	April, May, June, July, August, September	May and July
"	*longiusculus* Hine	June	———
"	*melanocerus* Wied.	July	———
"	*mexicanus* L.	May, June, August	Never common
"	*molestus* Say	May, June	June
"	*pumilus* Macq.	April, May, June, July	April and May
"	*stygius* Say	May	———
"	*sulcifrons* Macq.	July, August, September, October, November	September
"	*trimaculatus* P. B.	May, June, July, August	Never common
"	*turbidus* Wied.	May, June	May
"	*venustus* O. S.	June	———

From the standpoint of abundance of individuals, combined with the extent of their seasonal occurrence, five of the above species stood out from the rest as being the most annoying and harmful pests of stock. These were *Tabanus costalis*, *Tabanus fuscicostatus*, *Tabanus lineola*, *Chrysops obsoletus*, and *Chrysops vittatus*. Adults of these species occurred in abundance from the first of May to the first of September; a fact which was true of none of the other species taken. Adults of some other species appeared in greater numbers at certain times of the year but their attack extended over a more or less limited period. This was especially true of *Tabanus pumilus* which, during the short time in which it was abundant, caused more injury than any other species in the same period of time.

PRESIDENT A. G. RUGGLES: The next paper is by Mr. Arthur Gibson.

THE OCCURRENCE OF THE TORTRICID, *CACŒCIA ROSANA* L., IN CANADA

By Arthur Gibson, *Ottawa, Ont.*

Abstract

The tortricid, *Cacoecia rosana* L., was first recorded as a pest in eastern Canada in 1919, when it occurred in destructive numbers attacking particularly the foliage of bush fruits in the province of Nova Scotia. It was thought at the time that the species was new to science, and for this reason it was described by Busck as *Cacoecia hewittana*. Since 1919, the species has also been found in destructive numbers in the province of British Columbia. Notes on the egg and larval stages of the insect are included and also notes on parasites and artificial control.

On July 10, 1919, I received from a correspondent living in Sydney, Nova Scotia, a supply of raspberry leaves infested with a tortricid larva, with the statement that the caterpillars were effecting noticeable injury, not only to the foliage of raspberry but to that of currant, hawthorne, lilac and sycamore, as well. Moths reared from this material were submitted to Mr. August Busck, of the United States National Museum, and at my request, as the species was thought to be undescribed, he named it *Cacœcia hewittana*[1]. Dr. McDunnough, in immediate charge of our National Collection of Insects, has, however, since informed me that the species is *rosana* of Linnæus. I regret, therefore, for personal reasons, that the name *hewittana* must go into the synonomy. Mr. Busck, I understand, now agrees with us in this.

Cacœcia rosana L., has been known as a pest in North America for a number of years. Various references may be found in the literature, particularly by Messrs. Comstock and Slingerland, Lugger, Felt, Chittenden and Walden. In Canada, however, the infestation in Nova Scotia was the first I had record of, although since we have found in our collections specimens of the moth reared in Vancouver, B. C., in July, 1915, by Mr. R. N. Chrystal, who at that time was in our employ. Conspicuous injury to the foliage of young oak trees was noted at the time.

As indicated above, the larvæ occurred abundantly at Sydney, N. S., in 1919, feeding on and webbing the leaves together in characteristic tortricid manner. Our correspondent informed us that the raspberry bushes had been similarly infested during 1917 and 1918. Comstock and Slingerland[2] and B. H. Walden[3] refer to the habit of the larva in feeding on the terminal leaves of the plants, drawing them together and

[1]Canadian Entomologist, LII, 125.
[2]Cornell Univ., Agr. Exp. Station, Bull. XXIII, 120.
[3]Conn. Exp. Station, Rep. 1912, 223.

fastening them with silken threads, living within the enclosure thus formed.

In Canada, the larva has a wide range of food plants. In Nova Scotia it has been found on raspberry, currant, hawthorne, lilac and sycamore; in British Columbia on crataegus, hazel, birch, cherry, privet, plantanus, American elm, maple, oak, linden, laurel, lilac, rose, black currant, loganberry, willow, wild plum, lombardy poplar and blackberry.[4] In addition, in the same province in 1923, Mr. K. F. Auden, one of our Investigators, found the larvae on apple, plum, pear, ash and European broom (*Cytisus scoparius*).

Distribution in Canada

Cacoecia rosana L., has been found in Canada only in the provinces of Nova Scotia and British Columbia—so far as our records indicate. The actual localities are Syndey, N. S., Truro, N. S.; New Westminster, B. C., Vancouver, B. C., and Victoria, B. C. In the latter province its range according to Mr. W. Downes, in charge of our Victoria, B. C., laboratory, extends over the southern coastal region.

Description and Habits

The Egg. The egg is about .75 mm., in width, rounded in outline, much flattened, raised in centre, in general scale-like in appearance. When laid the egg is of a pale green color. The eggs are laid, on the bark, in a mass and overlap. In 1922, Mr. W. Downes, examined a number of egg masses and reported that the largest one contained 102 eggs, and the smallest 23, the average number in each mass being 60. As the eggs age, the mass becomes darker but not so dark as the bark upon which they have been deposited. The egg mass is irregular in shape, some being rounded, others elongated. In length the egg masses vary from 5 to 9 mm. Several masses may be laid close together, in fact we have found in several instances, the egg masses overlapping.

We have no data on the early stages of the insect in eastern Canada, but in British Columbia, Mr. Downes has informed me that in 1922, the eggs commenced to hatch about April 15, and that the actual date of hatching apparently depends upon the host on which they are laid. On April 26, at Victoria, B. C., egg masses on rose and poplar, both of which had begun to come into leaf, were found to be all hatched, but eggs laid on laurel, which had not at that time any young leaves, were still unhatched. On a small basswood tree, Mr. Downes counted 160 egg masses.

[4]Downes, in litt.

THE LARVA. At first the young larva is yellowish-white, the head being blackish. As it develops it becomes green in colour, the head and thoracic shield being dark brown or black. When mature the larva varies from 15 to 19 mm. in length. It is of a dull green colour without any markings. The tubercles are inconspicuous, faintly brownish in centre. Tubercular plates on first thoracic segment conspicuous, large, brown, or blackish. Setæ slender and pale brownish. Spiracles, pale, oval, brown-rimmed. Head 1.7 mm. wide, rounded, squarish, bilobed, reddish-brown, dark brown or black, shining; clypeus highly triangular, mouth parts reddish-brown; basal joint of antennæ pale; ocelli black. Cervical shield dark brown or blackish, the extent of dark colour varying in the specimens. Anal shield concolorous with body. Thoracic feet black, paler towards extremity, shining; prolegs concolorous with body.

When the larva reaches maturity it pupates among the leaves where it has been feeding. The larvæ received from Nova Scotia in 1919, had mostly all pupated by July 15, the length of the pupal stage being 9 days in one instance, others 10, 12 and 16 days. In British Columbia, in June, Mr. Downes found the pupal period to vary from 10 to 16 days, pupation commencing about the middle of that month. In 1923, according to Mr. Auden's records the pupal period varied from 10 to 14 days, the average being 11.

THE PUPA. Length 8 to 12 mm; width at widest part about 2.8 mm.; wing cases and thorax varies from light brown to black; abdomen light brown; cremaster darker brown with four rather stout curved bristles at terminus and two similar ones on either side. On each abdominal segment there is dorsally, two transverse rows of short stout spines. The skin between the rows of spines is finely pitted, that below each posterior row, coarsely pitted.

THE MOTH. This has been described recently by Mr. Busck[5] as above mentioned under the name *hewittana*.

PARASITES

Parasites were reared at Ottawa from Nova Scotia material, and at Victoria from British Columbia material. These have not been finally studied, but Mr. H. L. Viereck informs me that these are of four species, all probably undescribed. From Nova Scotia one species of *Angitia* was reared and from British Columbia material two species of *Angitia* and one species of *Ephialtes*.

[5]Canadian Entomologist, LII, 125.

Control

During the last two years, Mr. Downes, in charge of our Victoria, B.C., laboratory, has had excellent success in destroying the egg masses by spraying with the miscible oil known as Dormoil. Various infested bushes and trees were sprayed in the first half of April with this oil in the strength of 1–12 and 1–15. For the larvae he has recommended, in general, a spray of Black Leaf 40 one ounce, whale oil soap 8 ounces, lead arsenate (powder) 2 ounces, water 3 gallons, repeating as often as necessary, and to be applied particularly for the young larvae.

President A. G. Ruggles: We will now listen to a paper by R. L. Webster.

FACTORS AFFECTING DAMAGE TO CROPS BY INSECTS

By R. L. Webster, *Fargo, No. Dakota*

Abstract

The real significance of much insect damage is not fully appreciated, since it is often concealed. Much injury by insects is laid to other factors. The severity of damage by insects may be influenced greatly by temperature and moisture. Crops, the growth of which is retarded primarily because of lack of moisture will suffer more injury when attacked by insects than other crops not so retarded. Other conditions being equal, insect damage is more severe on the crop handicapped by reason of deficient moisture. Various types of soils in turn affect the severity of insect damage because of differences in their water holding capacity.

Damage to crops by insects often is considered to be due mainly to a single factor; the abundance or scarcity of the particular insect or insects concerned. That other factors may be involved is not questioned, but the extent to which these other factors may be concerned is a matter that has received comparatively little attention. In the Great Plains area, that region between the Rocky mountains and the Mississippi valley, characterized as it is by a limited rainfall, certain of these other factors affecting crop losses by insects are brought quite forcibly to our attention.

Factors Involved in Crop Losses

In the Yearbook of the United States Department of Agriculture for 1922, an attempt has been made to summarize the extent and causes of crop losses of various kinds so far as the wheat crop is concerned. Over a period of 14 years these estimates indicate average losses amounting to a total of 30%. The main factors listed are as follows; Deficient

moisture 12.1%; excessive moisture, 2.4% frost or freeze, 3.8%; hot winds, 2.2%; plant disease, 3.2%; insects 2.5%. These figures are obtained from estimates made by a large number of volunteer crop reporters over the country.

It is interesting to note that for both plant diseases and insects, the losses seem to be increasing in the later years for which estimates are given. This is likely to be due to a more adequate recognition of the real losses occasioned by these two factors, rather than to an actual increase in those losses.

Estimates of Damage by Insects

In entomological text books and in other articles regarding insect damage to crops, it is common to estimate that not less than 10% of the wheat crop is lost because of insect attack. There is a wide gap between estimates from these two different sources. Some of the reasons for this difference are brought out in this paper.

Much Damage not Easily Recognized

Damage to crops by large insects, such as grasshoppers, is readily observed. But much damage by insects to the small grains is insidious in nature. Many of the insects concerned are hidden within the plant tissue; some of them in fact spend the greater portion of their life beneath the surface of the ground. Often a large share of the crop may be infested with the Hessian fly, or by the wheat stem saw fly, with little evidence of such infestation that is externally visible. The total amount of the damage to crops usually is not appreciated because it is not clearly evident.

Where severe outbreaks of any insect occur, the damage is so conspicuous that its economic importance is recognized at once. But there is in addition a certain amount of damage by insects every year in any locality. As Folsom remarked in his classic study of the insects affecting red clover in Illinois, there is a constant drain on the plant thru attack by insects, unnoticed because it occurs every year. Losses of this nature probably are never taken into account in crop estimates.

Potential Damage

Moreover, a portion of the damage by insects is potential. A wheat field may be heavily infested with the Hessian fly or the wheat stem sawfly before cutting, yet suffer only a moderate amount of loss on account of lodging, if there are favorable weather conditions before

harvest. As a matter of fact, in the case of the sawfly, grain from infested heads may be actually heavier in weight than grain from uninfested heads. The great loss in the spring wheat country from such insects is occasioned by the falling of the grain to the ground before harvest.

Insect Damage Confused With That of Hail

Damage by the two insects just named may be mistaken for that of hail. On numerous occasions certain of my students who have spent summer vacations adjusting hail insurance have told me of claims put in by farmers for losses by reason of hail, which were in fact due to injury by the Hessian fly. The insect factor in adjusting hail losses has been considered of such importance that a little booklet[1] has been recently issued indicating means of recognizing injuries caused by various insects and plant diseases, which may be confused with that of hail.

Temperature

That temperature is an important factor in insect damage is well known. Injury to planted corn by the seed corn maggot is more pronounced during cool springs, when the seed remains in the ground for some little time before germinating. On the other hand, temperatures ranging higher than normal serve to accelerate the rate of development of insects, and consequently tend to increase the severity of their damage. This would be less important in the case of soil inhabiting insects, the rate of development of which would be regulated more by the temperature of the soil than by that of the air above.

Moisture

As deficient moisture is the most important cause for losses to wheat, it is also a very important factor in increasing the severity of insect losses to crops in general. It is obvious that plants, the growth of which have been retarded primarily because of lack of moisture, will suffer more insect damage than other plants that have not been so retarded. Because of a lesser amount of leaf surface, or total green weight available as food for destructive insects, the whole amount of damage will be more severe than under conditions where a sufficient amount of moisture for plant growth has been available. With an equal number of insects attacking it for each square rod or square mile, the crop growing under conditions of deficient moisture is bound to suffer insect

[1]Losses to Grain and Cotton. Hail Department. Western Adjustment and Inspection Company. (1919?)

damage more severely than one growing with an amount sufficient for a normal and continuous progress. Lack of moisture affects the insects very little since they are able to obtain this by consuming plant food.

On the other hand, a crop with superfluous moisture may also suffer from insect attack, altho by reason of different insects.

Deficient Moisture and Sod Webworms

An outbreak of sod webworms in certain counties in southwestern Iowa in 1918 serves to illustrate how insect damage may be quite severe under dry conditions. There was a deficiency of moisture in April and May 1918, coupled with a temperature several degrees higher than normal for the month of May. In that part of the state where the injury was most common, the surface features of the soil have been much eroded. In a geological sense, it is an old country. The damage by the sod webworms was most evident on the brow of the hills. The lower land suffered less from the insects probably due to a higher moisture content of the soil which may have been correlated with a higher content of organic matter. But the hilltops also were less injured. The most plausible explanation of all this is that the direct rays of the sun dried out quickly the surface moisture from the hillsides and so retarded plant growth but also served to accelerate the rate of development of the insects by reason of higher temperature, since the sod webworms feed on the roots close to the surface.

Deficient Moisture and Pale Western Cutworm

In 1921, in western North Dakota, severe damage by the pale western cutworm occurred to various crops, especially to wheat. Altho the cutworms were more numerous in 1922 than during 1921, less actual damage took place, mainly because of the abundance of moisture during the spring of 1922. In May 1921, at Beach, North Dakota, less than an inch of rainfall was recorded. This amount was two inches below the normal. During the same month in 1922, there was approximately 4 inches of rainfall, more than an inch over the normal amount for May. During 1921, the growth of all crops was retarded because of insufficient moisture. This lack of moisture had no such effect on the cutworms, which merely worked lower down in the soil and caused still more damage to crops by cutting off the stems below the growing point. With an abundance of succulent green food, a larger number of insects in 1922, caused a comparatively small amount of damage.

Soils

Soils vary greatly in their water holding capacity, due for the most part to difference in physical make up. A sandy soil may have a maximum water capacity of 11 or 12 % while in a silt loam soil, this may run as high as 40%. With deficient moisture, other conditions being equal, insect damage to crops will be the more severe on those soils having a low capacity to retain moisture.

In that particular area in North Dakota where the pale western cutworm has caused the most injury the soil is usually quite sandy. During periods of scant rainfall, this soil dries out quickly and there is little available moisture for plant growth. A mechanical analysis of the Beach fine sandy loam indicated 50% sands, 37% silt, and 11% clay. A soil of this character has a comparatively low capacity to hold moisture. There was much less injury on clay soils. An additional factor with the pale western cutworm is that the moths seem to prefer soil that is more or less loose in which to deposit their eggs.

During the past two or three years, grasshopper damage has been conspicuous in certain counties in northern North Dakota. This region coincides almost exactly with the old bed of glacial Lake Souris, an area characterized in particular by soils with a high content of sands and therefore with a low capacity for holding water. Crops attacked by grasshoppers in this particular area have suffered severely mainly because the prevailing types of soil are those with a limited water holding capacity, which retards plant growth but does not retard the insects attacking green plants. There is good reason to believe that the insects are no more abundant in this region than in other localities where less damage occurred.

Conclusions

In closing, it may be stated that the significance of much insect damage is not fully appreciated since it is often concealed. Much injury by insects is laid to other factors. Moreover, damage by insects may be influenced greatly by variations in temperature and moisture, both directly because of the effect on insects and also indirectly because of the effect on plant growth. Various types of soils in turn affect the severity of insect damage because of differences in the water holding capacity.

By reason of these different factors, it is practically impossible to estimate, with any degree of accuracy, the relative importance of any one of them. Altho many factors are involved in the destruction of crops

by insects, there is reason to believe that this damage has been under-estimated, rather than over-estimated.

PRESIDENT A. G. RUGGLES: We will now take up the discussion of the Presidential Address and I will call upon Vice-President Gossard to preside.

VICE-PRESIDENT GOSSARD: Our Presidents have always had the widest discretion in choosing their subjects. They tell us things that we ought to know in regard to the policy of the Association, changes recommended in our mode of functioning, etc. They give us instruction, inspiration and whatever recommendations they see fit. An address is significant, not only for what is in it, but also for what is not in it. If we do not find within the address any recommendations for changes in our policy, or in our manner of doing things, we take it for granted that our machinery is functioning satisfactorily, and that we are in a rather happy condition. I am also quite sure that a matter-of-fact address, given in brief time, is very acceptable to the Society. I think we have had, this morning, one of the shortest addresses on record, and the absence of any poetry in it certainly does not indicate that the speaker lacks idealism, for we had held before us some splendid ideals. It also should not indicate any lack of the prophetic spirit, because we had a good look ahead.

The address is now open to you for discussion.

MR. E. P. FELT: I wish to extend to our President a note of personal gratification in the dissertation with which he favored us. It struck me extremely timely that he should make the comparison as he did between the development of various early Entomologists at the time the American Association for the Advancement of Science was born.

We fail to realize, sometimes, how recent scientific work is in this country, and I am very willing to agree with the President in thinking that we are just at the beginning, that although those earlier men were pioneers, and are commonly regarded by us as pioneers, that in the near future, we in turn will be regarded as pioneers. You cannot help but feel that we are on the eve of tremendous projects—that we are reaching out to take advantage of the knowledge gained in other branches of science in order to make it our own so far as the advancement of Economic Entomology is concerned. I would also like to emphasize one point in this connection, and that is our Entomology is Economic only in proportion to which it is put into practice. Whatever ideas we may

have, whatever discoveries may be made— if they are not actually brought into practice, we have failed somewhere in our economic work. Investigation of the insect is not sufficient. We must sell the proposition to the American people.

MR. L. O. HOWARD: I have nothing but praise for the President's Address. It was an admirable address from start to finish, exceptional in its execution. I was delighted to have the President bring out the point, "What is an Economic Entomologist?" We have been through the phase where men in Museums look down on Economic Entomologists. We are now coming to a proper understanding, and it is becoming plain that all Entomologists are Economic Entomologists. We can't find out too much about entomology from any point of view. We have all been feeling that same note of hope, the same feeling that something big was about to transpire. The President has put into words, into admirable words, what many of us have half-formed in our mind. I consider the address a very exceptional one.

VICE-PRESIDENT GOSSARD: I am sure those who have spoken have expressed the sentiments of the entire Association. We certainly thank Mr. Ruggles for his interesting address.

President Ruggles resumes the chair.

PRESIDENT A. G. RUGGLES: The next paper on the program is by J. C. Hamlin.

THE AUSTRALIAN PRICKLY PEAR PROBLEM

By JOHN C. HAMLIN, *Officer-in-Charge Prickly Pear Investigations*

ABSTRACT

Several species of prickly pear cactus (Opuntia) are naturalized in Australia and constitute a national pest. Destructive utilization of the plant for many purposes, numerous mechanical and chemical destroyers have failed to halt the occupation of fresh lands by this plant curse. The fungous, bacterial, and insect enemies of Opuntia are now being introduced into Australia in an effort to control this pest.

INTRODUCTORY STATEMENT

This paper deals with an American group of plants, the prickly pears of the genus Opuntia. While not of the genus Cereus, these plants are in fact quite serious. The rabbit episode is eclipsed and the prickly pear cactus is today Australia's spiniest problem. I must forego relating the interesting history of their introduction to Australia.

ACREAGE AND DISTRIBUTION IN AUSTRALIA

The pest occurs mainly in eastern Australia where the infestation

totals 30,000,000 acres. In Queensland over 24,000,000 acres are infested and in New South Wales upward of 5,000,000 acres. These almost incomprehensible figures total 46,000 square miles—or an excess of 5,000 square miles over the entire area of the State of Ohio!

During 1916–17 the excess of cactus over all Australian crops was about 4,000,000 acres.

The pear infestation extends roughly from Sydney, New South Wales, to north of Rockhampton, Queensland, or from 22 degrees to 30 degrees South Latitude. In general the rainfall of eastern Australia decreases toward the interior, and prickly pear is found mainly in the region of from 20 to 40 inches of annual rainfall. The pest grows in open forest country as well as on open stretches.

During the past ten years in Queensland alone the average annual spread has been more than 800,000 acres, or 2,300 acres per day. The annual increase in both States is today well over one million acres. The pest propagates readily both vegetatively and by seeds, so that flood waters, cattle and birds are the more important agents of dissemination. The birds implicated are the emu, crow, and the black magpie.

Species of Opuntia in Australia

About fifteen species of Opuntia are naturalized in Australia. Two species, the "common pest pear" (*Opuntia inermis*) and the "spiny pest pear" (*O. stricta*), cover the bulk of the cactus area.

Early Attempts at Control

Since 1900 the importance of the pest has become increasingly appreciated, and many suggestions for its riddance have been considered. These proposals have included its destructive utilization as cattle feed, green manure, and for manufacuring alcohol, potash, oxalic acid and fibre for paper making. All proved futile.

Numerous mechanical devices for pear destruction are useful on small areas of very valuable soil.

Chemical research has determined that the injection of certain arsenicals is the best method of poisoning prickly pear. The applicability of this method is limited to areas of scattered, accessible pear and the cost limits its usage to valuable land.

While most important, these measures do not alter the face of the national problem..

Preliminary Biological Work

In 1910 Mr. Henry Tryon, Government Entomologist of Queensland,

suggested the importation of cottony cochineal insects to combat the plant pest. The Queensland Traveling Commission, after two years study throughout the world, recommended the introduction of the natural enemies of the plant from the Americas.

From Ceylon this Commission sent a cochineal (*Dactylopius indicus* Green) to Queensland which was found to be restricted, not only to cactus, but even to a single species of *Opuntia* called the "tree pear." It was liberated in the Suttor River region where the bulk of this species (*O. monacantha*) occurred.

The intervention of the war postponed action on the Commission's recommendation, and the cochineal shifted for itself, more or less. At the expiration of the war this cochineal was found practically to have rid Queensland of the "tree pear" and not to have attacked other plants. In 1920 the Commonwealth Prickly Pear Board came into being to tackle the problem from the biological angle.

The Work of the Commonwealth Prickly Pear Board

Preliminary arrangements completed, Doctor Harvey Johnston, Scientific Controller of the Board, returned to Australia to receive shipments from South America by Mr. W. B. Alexander and from North America by the writer.

The work done in Argentine showed the presence of several valuable organisms. These include two species of moth-borers (*Cactoblastis cactorum* (Berg) and *C. bucyrus* Dyar), two species of pyralids attacking new growth (*Mimorista* sp. and *M. pulchellalis* Dyar), and two cochineals (*Dactylopius* sp. and *D. indicus* Green). Argentine diseases of prime importance are *Sclerotinia cactacearum* Speg., *Phytophthora cactorum* Speg., and *Montagnella opuntiarum* Speg. None of these organisms are established in Australia.

The North American work has been carried out from Florida to California and over northern Mexico. The previous work of Dr. W. D. Hunter on cactus insects has been an invaluable aid to the project. Both the Board and I have been particulary fortunate in having Doctor Hunter direct the investigations on this continent.

The important cactus diseases of North America are cactus anthracnose (*Gloeosporium lunatum*), zone spot, (*G. cactorum*), a bacterial soft-rot, and cactus scab (*Hendersonia opuntiae*). The phytopathological phase of the project will not be dealt with further here.

Twenty-three of the more important true cactus insects were selected for introduction to Australia, the plan being to rely for success upon this

complex, attacking every part of the plant in a variety of ways. Sixteen species create the primary injury and seven scavengers assist by extending this damage. The plant feeders include two moth-borers (*Melitara*), destroying the joints internally; three coreids (*Chelinidea*) and two cochineals (*Dactylopius*), devitalizing the joints externally; one pyralid (*Mimorista*) destroying the new growth externally; one pyralid (*Noctuelia*) destroying the green fruits internally; one cecidomyiid (*Asphondylia*), inhibiting the development of seeds; one cerambycid (*Moneilema*), injuring the roots internally; one coreid (*Narnia*), devitalizing the fruits externally; and four weevils (*Gerstaeckeria*), injuring the joints internally. The secondary insects include seven dipterous scavengers: five syrphids (*Volucella* and *Copestylum*) and two stratiomyids (*Hermetia*).

The American phase of the project consisted in collecting the selected species, breeding free from parasites, packing to withstand the long journey, and shipping them under the most favorable conditions. Space prohibits presenting these phases.

The Insects in Australia

All of the species reached Australia alive but only 14 were reared there. Nine species proved effective, and five of these have increased rapidly.

Shipping across the equator to directly opposite seasons has constituted a great difficulty in establishing the insects.

The cochineals propagate most rapidly. The pyralid attacking new growth reproduces monthly during the long summer. The moth-borer of Texas sustains a larval mortality of 80 percent, due largely to crowding, and yet increases each generation at the ratio of about 16 to 1. This two-brooded species has three broods in Australia, and now numbers over one million individuals in Australian laboratories.

Tests of the cactus insects on economic plants will be completed by May next, when the desired and desirable species will be liberated.

The Outlook

Several of the introduced insects promise much damage to Australian pear in the absence of their natural enemies. The detrimental influence to be exerted against the newcomers by Australian parasitic and predaceous forms is largely problematical. Several ants are known to destroy the lepidopterous larvae and hemipterous nymphs, while the cochineals will be greatly handicapped. However, we have already seen that certain species increase rapidly despite a heavy mortality.

The failure successfully to establish the American scavengers promises

to be offset by the observed disposition of three Australian scavenging flies to breed in decomposing cactus when available.

One of the cochineals (*Dactylopius tomentosus* Lamarck) was privately imported and liberated. From this we know definitely that it is capable of destroying the two most serious pest pears, and also that an Australian ladybird beetle (*Cryptolaemus montrousieri*) will greatly lessen the efficiency of the cochineals.

Ultimately, the value of the insects must be determined by their action as a complex in the field over a considerable period. After becoming acclimated, if they are able successfully to cope with the environmental factors, the insects should, in time, change the pest from a spreading menace to a stationary or regressive factor in the Australian flora. At best many years will be required to bring this about. Complete eradication is beyond reasonable expectation but biological control is quite within the realm of possibilities.

This prospect is so far based entirely upon the reduced insect complex from the United States. The Argentine has other important cactus insects. My recent survey of Mexico revealed three other insects biologically valuable in this connection. Again diseases of cactus are of prime importance and would undoubtedly greatly accelerate the control of the pest. With the addition of these organisms to the complex already established the chances of success in this unique biological problem will be greatly enhanced.

President A. G. Ruggles: The next paper is by E. P. Felt.

THE GIPSY MOTH PROBLEM IN NEW YORK STATE

By E. P. Felt, *Chief Entomologist, Conservation Commission, Albany, N. Y.*

Abstract

The gipsy moth, *Porthetria dispar* Linn., has been found in small numbers near or on most of the eastern border of New York State, thus necessitating close scouting and clean up work in nearly all of the proposed barrier zone some 25 miles wide and extending from Long Island Sound north to the Canadian border. Available data indicate a relatively slow spread in the Connecticut valley and even more favorable conditions for control work along much of the border in New York State. There was somewhat rapid spread on the eastern slope of the Berkshires and this may also be expected if the pest is allowed to establish itself in the Catskill and Adirondack mountains. Liberal Federal aid is considered essential to the maintenance of a barrier zone.

New York State is bounded on the east by gipsy moth infested territory, practically speaking. At least, the finding of a series of in-

festations here and there in western Vermont from the southern to the extreme northern part, a number being within a few miles of the New York border and several very close to our largest timbered area, the Adirondacks, would seem to justify such a statement.

There has been in the past few months an extension of the infested area along the New York State line of nearly 150 miles. It is a serious situation and means that practically the whole of the proposed barrier zone from Long Island Sound north to the Canadian Border must be brought under very close supervision at once, if we are to prevent the westward spread of this very destructive pest of fruit, shade and forest trees. That is, very careful scouting and clean up work must be carried on over a strip more than 300 miles long and at least 25 miles wide. The physical proportions of the undertaking are enormous. It is no less than an actual attempt to arrest the progress of an insect which has become established throughout practically all of New England and is now pressing westward. The project, though huge, is by no means hopeless. Its successful execution demands the best that can be given and depends upon a thorough understanding of all phases of this exceedingly varied proposition and ability to solve early, new and pressing problems inevitable in an undertaking of this magnitude. The possibilities of changes in food preferences, the feasibility of modifying forest composition, both very difficult from the investigational side, are two phases which may have a very practical bearing upon checking the spread of this pest. Residents of eastern New York, for example, are now being urged to cut, so far as practicable, the more favored food trees, such as pasture oaks, wild or worthless apple trees and both gray and paper birch, and to leave less favored trees, such as maples, and thus make control work easier.

The 30-year fight in New England demonstrated the possibility of the barrier zone. It is economical, though costly. Investigations the past summer show that we may expect less spread through the agency of winds than farther east, due to the greater prevalence of westerly and southerly winds in eastern New York at the time young gipsy moth caterpillars are likely to be carried by air currents. An examination of the gipsy moth quarantined areas in earlier years shows that the pest extended its range to the Connecticut River in southern Vermont in 1912; that two years later the river was the dividing line in both northern Massachusetts and southern Vermont and eight years later, 1921, the boundary of the infested territory in Massachusetts was practically identical with the Connecticut River and that in southern Vermont the

line had been pushed 15 to 20 miles west of the river. It is believed that westward spread was materially hindered by the greater prevalence of westerly winds in this area than farther east and the less favorable physical characters, a smaller proportion of woodland and more open country, for the development of large infestations, thus making control work relatively easy. The winds of the Hudson and Champlain valleys are, as shown by figures available, less favorable to westward spread than those of the Connecticut Valley, due mostly to the sharper north and south valleys in eastern New York and western New England. The physical features of the Hudson Valley at least are fully as favorable to control work as are those of the Connecticut Valley. The latter is not true of the Champlain Valley, though the lake and the adjacent higher mountains result in a considerably greater proportion of north and south winds and thus materially lessen the hazard of western drift.

Referring once more to the extension of the quarantined area in western Massachusetts, it will be noted that it was much more rapid on the eastern slopes of the Berkshires than in the Connecticut Valley or east of it. There was apparently a more rapid spread up the hills caused in part by the warm winds of spring ascending sunny slopes. A similar development may be expected if the Gipsy Moth is allowed to establish itself on the eastern slopes of the Catskill and Adirondack mountains. Nothing but intense close work from now on can prevent this.

We are confronted by cold realities. It is well known that wind-spread is roughly proportional to the amount of infestation. Consequently, in spite of the favorable factors outlined above, it is essential that the infestation immediately east of the barrier zone for a distance of at least 40 miles in northern New England and 25 miles in the southern portion be kept down to a practicable minimum. We are looking to the Federal Government as the one agency which should take care of this phase of the problem and that early the coming spring. It is admitted that New York State has an immediate and compelling interest in preventing the further invasion of her territory by this pest and yet the work means similar protection to a very large proportion of the United States and the Federal Government therefore is deeply concerned in the matter. The maintenance of an exterminative fight over such an extended front, in a thickly settled prosperous area such as the Hudson Valley, is more than one state should attempt and probably more than it can be induced to assume for a long series of years without very material assistance from some other agency.

The gipsy moth problem cannot be evaded. Spread and individual control or lack of control, both extremely costly, the latter possibly ruinous, are inevitable unless the state and nation continue the work already started. There is no reasonable hope of a materially shorter barrier zone. Those familiar with the situation realize that it must be either the proposed line or simply general repressive work over a constantly increasing area accompanied by mounting costs and unsatisfactory control in our large and valuable forest areas. A failure on the part of the Federal Government to assume early a reasonable share of the expense of protecting the remainder of the country from this insect may force the abandonment of one of the most important projects in economic entomology.

PRESIDENT A. G. RUGGLES: A paper will now be presented by S. S. Crossman and R. T. Webber. It will be read by Mr. Crossman.

RECENT EUROPEAN INVESTIGATIONS OF PARASITES OF THE GIPSY MOTH, *PORTHETRIA DISPAR* L., AND THE BROWN-TAIL MOTH, *EUPROCTIS CHRYSORRHOEA* L.

By S. S. CROSSMAN, *Entomologist, Bureau of Entomology*, and R. T. WEBBER, *Assistant Entomologist, Bureau of Entomology*

ABSTRACT

The paper pertains to recent investigations in Europe of the Gipsy Moth and Brown-tail moth and their natural enemies. Mention is made of the previous work which resulted in the introduction of 36 species of Tachinid and Hymenopterous parasites and 10 species of beneficial Coleoptera. Of the 46 species named, 15 have actually been established.

In several instances the original numbers imported were so few that breeding had to be done before enough individuals could be obtained for colonization and in a few cases a sufficient number were not received to make breeding for liberation possible.

As the species have become established, the material for new parasite colonies has been obtained by breeding it at the laboratory and the different species have been colonized further out from Melrose until about 75,000,000 individuals have been liberated over much of the moth infested area. Several of the parasites are now present in many of the towns on the border of the infestation and one species, *C. concinnata*, is being recovered from native hosts 60 miles beyond the quarantine line.

The records of parasitism which are being obtained at the Gipsy Moth Laboratory are excellent and show that a great deal of benefit is being derived from these introductions, yet the combined good has not been great enough to trust in them alone for the Biological Control of these two injurious insects.

During the spring and summer of 1922 the senior author investigated the Gipsy Moth and Brown-tail Moth situation in several countries in Europe and in the spring of 1923 the writers visited France, Spain, Italy, Germany, Austria, Hungary,

Roumania and Poland. Many entomologists were consulted and many of the forest areas in these countries were searched for infestations.

A suitable gipsy moth infestation in which to work was found at Debrezcen, Hungary. The infestation was of medium intensity, located in a mixed growth of Locust, *Pseudo-acacia* L., *Quercus pedunculata* Willd., Populus and Salix. Over 100,000 gipsy moth larvae and pupae were collected from which nearly 44,000 parasites were obtained and sent or brought to America for liberation and study. A few experiments were carried on at Debrezcen to determine the percentage of insect parasitism of *dispar*. The data obtained from this work indicated that 71% of the last two larval stages were killed by parasites. The following parasites were involved: *Parasetigena segregata* Rond., *Blepharipa scutellata* R. D. *Tachina larvarum* L., *Carcelia gnava* Meig., *Lydella nigripes* Fall., *Zenillia libatrix* Panz., *Sturmia gilva* Hartig., *Compsilura concinnata* Meig., *Apanteles fulvipes* Hal. Of the list, *P. segregata* was by far the most abundant parasite reared and killed about 40% of the larvae.

The authors point out the fact that the predominating parasite in one area will not necessarily be the most abundant one in another area and that as many as possible of the foreign parasites of the Gipsy Moth and Brown-tail moth should be introduced.

The benefits derived from the Gipsy Moth and Brown-tail moth parasite introduction work are not confined to these insects, for several of the introduced speciesare attacking many native insects. They were also found attacking vigorously a recently introduced European pest, the Satin Moth, *Stilpnotia salicis* L.

In Europe the Gipsy Moth and Brown-tail Moth have their periods of great abundance followed by periods of inconspicuousness. There are at present in several places in Central Europe small areas where there are light to medium infestations of *P. dispar* and the indications are that *dispar* is again on the increase in parts of Europe.

This paper pertains to recent work in Europe with the gipsy moth and brown-tail moth and their natural enemies. Because of the limited amount of time allowed for its presentation, it must be much abridged so that very little can be told of the details of the work. Neither can it be possible to mention by name many European entomologists who by their interest and able assistance made the work more pleasant and helped materially in the results accomplished.

As long ago as 1901, when the State of Massachusetts had discontinued its project of the extermination of the Gipsy Moth, *Porthetria dispar* L., the first[1] steps were taken by Dr. L. O. Howard, Chief of the Bureau of Entomology, to introduce into the United States the natural enemies of this threatening insect. This start was small and no liberations were made as the insects were dead when received, but it was the beginning of a huge experiment which grew to the extent of introducing 36[2] species of Tachinid and Hymenopterous parasites and 10[3] species of

[1]Report of the Entomologist, 1901, p. 143.

[2]**Anastatus bifasciatus* Fonsc., *Apanteles fulvipes* Hal., **Apanteles lacteicolor* Vier., **Apanteles melanoscelus* Ratz., *Apanteles solitarius* Ratz., *Apanteles vitripennis* Hal., **Blepharipa scutellata* R. D., *Carcelia gnava* Meig., *Chalcis flavipes* Panz., *Chalcis*

beneficial Coleoptera as enemies of the Gipsy and Brown-tail moths. The species starred are positively established. It is still possible that a few of the above species which are not recorded as established may be present although they have not been recovered in many attempts to do so.

In 1905, when the State of Massachusetts and Congress appropriated funds for the introduction of the natural enemies of these two dangerous insects, the work was continued in large proportions until 1912 when it seemed desirable to take account of stock and to give more attention to the proper colonization of the species then established and to ascertain the possibilities of the new insect friends.

In 1914 the European work was again started, but had hardly gotten under way when the outbreak of the world war made it necessary to discontinue all such projects. From that date until the present the force at the Gipsy Moth Laboratory has been largely engaged in assisting the spread of the established beneficial species and in determining their value as enemies of the pests concerned.

Of the 46 species introduced, 15 are positively established. In several instances the original numbers imported were so few that breeding had to be done before enough individuals could be obtained to warrant colonization, and in a few cases a sufficient number did not arrive to make breeding for liberation possible. Each year since 1912 the parasites have been colonized further out from Melrose Highlands until at present several of them are in the towns on the border of the infestation, and one species, *Compsilura concinnata*, is being recovered from native insect hosts 60 miles beyond the Gipsy Moth quarantine line. As the species have become established the material for new colonies has been obtained by breeding it at the laboratory or by securing it from its hosts, and with one species by separating parasitized host eggs from the eggs containing host larvae, until at this time approxi-

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obscurata Walk., **Compsilura concinnata* Meig., *Crossocosmia sericariae* Corn., *Crossocosmia flavascutellata* Shiner, *Lydella nigripes* Fall., *Ephialtes examinator* Fab., *Ephialtes compunctor* L., *Eudoromyia magnicornis* Zett., **Eupteromalus nidulans* Foerst., **Hyposoter disparis* Vier., *Masicera silvatica* Fall., *Meteorus japonicus* Ash., *Meteorus pulchricornis* Wesm., **Meteorus versicolor* Wesm., **Monodontomerus aereus* Walk., *Pales pavida* Meig., *Parasetigena segregata* Rond., (*Parexorista*) **Carcelia laxifrons* Villen., **Schedius kuvanae* How., (*Zygobothria*) **Sturmia gilva* Hartig, (*Zygobothria*) **Sturmia nidicolor* Towns., *Tachina japonica* Towns., *Tachina larvarum* L., *Telenomus phalaenarum* Nees., *Trichogramma* spp., *Tricholyga grandis* Zett., *Zenillia libatrix* Panz.

[3]*Calosoma chinense* Kirby, *Calosoma inquisitor* L., *Calosoma reticularum* Fab., **Calosoma sycophanta* L., *Carabus arvensis* Hbst., **Carabus auratus* L., **Carabus nemoralis* Mull., *Carabus violaceus* L., *Carabus glabratus* Payk., *Procrustes coriaceus* L.

mately 75,000,000 parasites have been colonized over much of the infested area.

The records of parasitism which have been obtained at the Gipsy Moth Laboratory are very promising and show that a great deal of benefit is now being derived from these introductions and the colonization work, yet the combined good of these benefactors has not been great enough to trust in them alone for the Biological Control of the Gipsy Moth and Brown-tail Moth. Because of these facts and also because many of the above mentioned 46 introduced insects were never colonized in sufficient numbers in this country to expect their establishment, it was decided in 1921 to attempt again to introduce and establish in this country more species of foreign parasites of the Gipsy Moth and the Brown-Tail Moth.

During the fall of 1921 Mr. A. F. Burgess, Entomologist in Charge of Gispy Moth and Brown-Tail Moth Investigations, made arrangements to have more foreign work done and during the latter part of January 1922 a consultation was held with Dr. Howard, after which Dr. J. N. Summers was sent to Japan and the senior author of this paper to Europe.

In Europe: France, Spain, Italy and Germany were visited and conferences were held with many of the leading entomologists of these countries. Most of these entomologists knew of no gipsy moth infestations in their country that year, and long hours of search by the writer failed to locate suitable infestations for parasite importation work.

An idea of the scarcity of this insect over much of Europe in 1922 is shown by the fact that only one gipsy moth egg cluster was found in two weeks search in the northern part of France, and a few days scouting in an area about 150 miles north of the south coast of France. A remarkable feature is that much of this scouting was done in areas where the growth was favorable for the insect. A few very light infestations were found along the southern coast of France and in Italy and Sicily. In Spain several gipsy moth infestations were present. One in the Royal Forest near Madrid and another about 150 miles south of Madrid near Villanueva de Cordoba were reported more severe than the others. Through the kindness of Dr. Manuel Aulló, Director of the Service of Study and Extinction of Forest Plagues of Spain, the infestation in the Royal Forest was visited and found to be a severe one. It was surprising that the infestation was of several years standing and yet no dead or dying trees were observed.

The empty cocoons of *Apanteles vitripennis* were very common at this infestation. They were also seen scatteringly at the infestations which were found in France, Italy and Sicily, but at the latter place *Apanteles melanoscelus* far outnumbered *vitripennis*. *A. melanoscelus* is one of the European parasites which is now well established in the United States, but as *vitripennis* is not here, arrangements were made with the authorities in Spain and with Dr. W. R. Thompson of the Bureau of Entomology at Hyeres, France, to make some shipments during the summer in an attempt to establish this species in America. A few shipments were received at the laboratory but as the Apanteles which were recovered were all males, no colonization resulted.

Germany was visited next, and was scouted very thoroughly. More gipsy moth infestations were found here than in France or Italy, but they too were in all cases very light. The heaviest infestations were found in the vicinity of Berlin, and the fact that nine men collecting for two days during the first week in July and again for two days in the middle of July were able to collect only 574 larvae indicates the scarcity of *dispar* in this area. These larvae were dissected to determine the percentage of parasitism, which was found to be very low.

By correspondence it was learned that conditions were similar over most of Europe and no infestation was heard of except a very light one in Hungary from which a few larvae were received in Berlin.

Because of the scarcity of the Gipsy Moth and of the Brown-Tail Moth in 1922 in Europe, it was not possible to make any large shipment of their parasites. The parasite problem was discussed with many entomologists and many records were made of previous infestations. A manuscript of the results of the Japanese investigations is being prepared by Dr. Summers.

The senior writer went again to Europe in March 1923 and this time he was accompanied by Mr. R. T. Webber of the Bureau of Entomology. Dr. J. N. Summers of the Bureau visited Japan a second time. In Europe: France, Spain, Italy, Germany, Austria and Hungary were visited by the writers, with results similar to those of the previous year, except that the infestations in Spain were much heavier and those in Germany had increased slightly over conditions in 1922. In Hungary near Budapest, in company with Prof. J. Jablonowski, Director of the Experiment Stations of Agriculture, a light gipsy moth infestation was found. Through the kindness of Dr. G. Horvath, Director of the National Museum at Budapest, and Dr. A. Schmidt, an entomologist of the Museum, an assistant, Mr. J. Ujhelyi, also of the Museum, was

employed and several trips were made from Budapest in search of a more favorable infestation in which to work, but without success until finally at Debrezcen, which is about 120 miles east of Budapest near the Roumanian frontier, a suitable infestation was located. Here arrangements were made to use a small building located on the edge of the forest for an insectary, and an order was placed for the making of a number of trays to be used in the rearing work.

Having found an infestation in Hungary and knowing that a heavy infestation was present in Crimea, which we had been advised not to visit because of the unsettled conditions in that country, it was especially desired to visit the area between Hungary and Crimea. Accordingly Mr. Webber went to Roumania while the senior author travelled to Poland. Several infestations were found in Roumania by the junior author. In one infestation in Tinca, *Calosoma sycophanta* was very abundant and many of the large caterpillars carried Tachinid eggs. The cocoons of two species of Apanteles also were observed. Another location was visited at Comana where there had been a heavy infestation the year before and where parts of the forest had been stripped, but this year there were practically no egg clusters to be seen and only a light infestation was presenet. As the season was getting late, Mr. Webber returned to Debrezcen, Hungary, and stayed there for the remainder of the season.

Two infestations were located in Poland, one at Lucks, which is near the eastern boundary, and one along the Vistula near Thorn in Northwestern Poland. Both of these infestations were very light and not suitable for securing parasites in appreciable numbers, and the senior writer returned to Debrezcen.

The forest at Debrezcen covers an area of several square miles, much of which is a solid stand of locust, *Robinia Pseudo-acacia* L., but which has smaller areas of mixed growth consisting of oak, *Quercus pedunculata* Willd., locust, Populus and Salix. In the mixed growth areas the oak predominates. The area was not a solid forest stand, but was broken with small clearings and vegetable gardens scattered through it, quite similar to areas in southern Massachusetts, except for the solid stand of locust. There was considerable undergrowth and a good variety of lepidopterous larvae present. The gipsy moth infestation was of medium density and was in the mixed growth.

A number of school boys were employed and daily collections of gipsy moth larvae were made. These larvae were placed in trays at the insectary where they were fed until the parasite maggots issued. As

fast as these maggots issued they were removed to a box containing slightly dampened sawdust and allowed to remain there until ready for shipment to America.

There were about 115,000 gipsy moth larvae and pupae collected, from which 43,873 parasites were obtained. This amounts to about 40% parasitism of the host. The actual percentage of parasitism of the large gipsy moth larvae is more correctly shown by the following figures which were obtained by careful work from seven small trays, each of which contained 100 fifth and sixth stage larvae. Of the 700 larvae, 498 or 71% were killed by parasites, about 1% died of disease and 28% lived through to maturity. The parasites involved were: *Parasetigena segregata* Rond., *Blepharipa scutellata* R. D., *Tachina larvarum* L., (*Zygobothria*) *Sturmia gilva* Hartig, *Lydella nigripes* Fall, *Carcelia gnava* Meig., *Zenillia libatrix* Panz, *Compsilura concinnata* Meig., and *Apanteles fulvipes* Hal. Of the list *Parasetigena* was by far the best parasite, killing nearly 40% of the larvae; *B. scutellata* followed, killing 24%; *T. larvarum* and *S. gilva* killed about 3% each. The other parasites were of very minor importance in the collections handled.

Attention should be brought to the fact that the records of parasitism were obtained from the large larvae and pupae of the host and that had it been possible to make similar collections of the earlier stages, a number of other parasites would have been encountered.

As the parasite material began to accumulate it was necessary to prepare it for shipment to America. It was known that the Apanteles would issue and die before their arrival in the States unless it was possible to ship them by cold storage. With the Tachinids—those species which have but a single generation and were to hibernate in their puparia—the problem was simple, but for the species which have more than one generation, cold storage during transportation was necessary. Several methods of packing for shipment were tried. The puparia were packed in slightly dampened moss or sawdust, in different types of containers. Some packages about 6 in. x 4 in. in size were packed full with alternate layers of sawdust or moss and puparia. Other shipments had puparia separated in small lots of from 5 or 10 to 100 in pill boxes with sawdust or moss. When the packages were ready for shipment they were either carried or sent by mail to the coast where they were repacked if necessary and placed in cold storage on steamers for America.

A few small lots of Apanteles cocoons and Tachinid puparia were sent from Debrezcen by mail direct to Melrose Highlands, Mass. These were in specially constructed containers 8 in. x 2 in. x 2 in., so made that

as the adults issued they could leave the compartment in which were the sawdust and puparia or the cocoons and go into an outer compartment where there was a supply of food and room for them to move about. These shipments were not successful as the adults issued and died en route. There should be more experimenting with this type of shipping cage. It is believed that the sudden change in temperature and humidity which accompanies the placing of Tachinid puparia or Apanteles cocoons in cold storage must be harmful to the development of the parasites, especially while they are going through the delicate transformations from larvæ to pupæ to adults.

At the close of the season's work large numbers of parasites were brought as hand baggage by the writers to Melrose. These parasites were packed by different methods and were not placed in cold storage.

The final results of these transportation experiments cannot be given yet, as a large amount of the material is in hibernation, and until the issuance of the material in the spring is completed the whole story cannot be told. However, from the appearance of the parasites upon arrival at the laboratory, a few general statements can be made. For Tachinid puparia which are to hibernate as such, cold storage is not necessary and appears to be detrimental. For Tachinids and Apanteles, which are summer-issuing, cold storage is not satisfactory, but is necessary until a better method is developed. A few Tachinid puparia packed with slightly dampened sawdust in small containers such as pill boxes arrived at Melrose in much better condition than when packed in larger containers. Slightly dampened sawdust was much superior to moss for Tachinid puparia. The sawdust used was apparently from hard wood and was very fine.

All steamers on which shipments were sent were met upon arrival in New York and the material was taken directly to the Gipsy Moth Laboratory where the packages were opened in a tight room, reserved for the purpose, to avoid the escape of any hyperparasites. In this room the material was sorted according to species and then distributed for future care. Those species which have but a single generation were placed in various types of containers for hibernation and the summer-issuing species were used for breeding experiments.

The following summary lists the European Tachinid parasites of the Gipsy Moth which were received at the Melrose Laboratory this summer:

Parasetigena segregata	27,248
Blepharipa scutellata	9,148
Tachina larvarum	144
Carcelia gnava	75
Lydella nigripes	114
Zenillia libatrix	16
Sturmia gilva	227
Compsilura concinnata	6
Total	36,978

The difference in the numbers which were reared and the numbers actually received is accounted for by so many different handlings and the necessary opening of packages at frontiers for customs inspection. In one case quite a number of Tachinid maggots which were in sawdust in a suit case being transported from Debrezcen to Budapest for repacking, worked their way out through the corners of the case and dropped onto the seats below, much to the discomfort of the passengers in the compartment.

In addition to the Tachinids mentioned above, 2481 cocoons of *A. fulvipes* were received from which 230 adults were obtained. These were bred through several generations at the laboratory and 15,000, adults were liberated in New England during the summer and fall of 1923.

At present it seems somewhat doubtful whether *A. fulvipes* can be established in New England, because of its need of a suitable hibernating host. However, there is still a possibility and the attempt to introduce this species should not be discontinued until it is positively proven that it cannot be done. The establishment of Parasetigena in New England seems reasonable to expect. It is single-brooded and has been reared from other hosts but it does not appear that these are necessary for its establishment. The several other species introduced this summer were not obtained in numbers sufficient to liberate and were used for life history investigations.

The fact that several species of Tachinids were recovered in relatively small numbers as *dispar* parasites at Debrezcen in 1923 does not signify that these species are always minor parasites. In other areas some one of them might be the predominating species. In Europe one species of parasite will predominate in a certain year in one area, while in another section a different species will be the most abundant. In New England some of the introduced parasites are very local in their activities and host larvæ collected in one area will show a high percentage of parasitism

while a similar collection made nearby may show a very few parasitized larvæ.

The results which are being derived from the introductions of insect enemies of the Gipsy Moth and the Brown-Tail Moth are excellent, but thus far they have not been great enough to prevent the increase of these species and it appears that more species of foreign parasites are necessary to bring about the desired results. The benefits are not confined to these two pests alone, for several of the introduced species are attacking many native insects and they were also found attacking vigorously a recently introduced European pest, the Satin Moth, *Stilpnotia salicis* L.

In Europe the gipsy moth and the brown-tail moth have their periods of great abundance followed by periods of inconspicuousness. At present in several places in central Europe there are small areas where there are light to medium gipsy moth infestations and the indications are that *dispar* is again on the increase in parts of Europe.

The exact causes for the periodical outbreaks followed by almost a complete disappearance of these insects in Europe are not well understood. There are many factors involved, and the whole situation should be thoroughly studied in Europe in an endeavor to determine what the various factors are so that as many as possible of the beneficial insects can be introduced into the fauna of the infested area in America.

President A. G. Ruggles: The next paper will be presented by Mr. C. P. Clausen.

A PRELIMINARY REPORT ON THE FOREIGN PARASITES OF *POPILLIA JAPONICA*

By Curtis P. Clausen and J. L. King, *Specialists U. S. Department of Agriculture, Bureau of Entomology, Yokohama, Japan*

Abstract

A general report on the progress of investigations for the parasites of the green Japanese beetle (*Popillia japonica*) in Japan and Korea. The parasites found comprise three Tachinids upon adult beetles, two Dexiids and five Scoliids upon grubs, and one predator, Shipments totalling 326,000 individuals, in various stages, have been forwarded to the Bureau laboratory at Riverton, New Jersey, for colonization

The foreign work in connection with the search for the natural enemies of the green Japanese beetle (*Popillia japonica*) in Japan was instituted in the early Spring of 1920 with the assignment of the senior

author to that field, and he was joined by Mr. King at the end of that year. Investigations have been in progress continuously since that time, being confined for the first two years to Japan and extended in 1922 to Korea.

Popillia japonica is found on all of the main islands of Japan, but does not extend to the Asiatic mainland, and is most abundant in the northern half of Japan in a habitat corresponding somewhat to that of the north central states. Nowhere is it an economic pest. Its life cycle differs somewhat from that in America, and may be summarized as follows for the three main localities in which studies were made. At Yokohama one complete generation occurs each year, with adult beetles present from late in May to the end of July only. At Koiwai, about 300 miles north of Tokyo, the cycle corresponds quite closely to that in New Jersey, except that possibly 25–30 per cent have a two year cycle. At Sapporo in Hokkaido, the most northern island, and about 900 miles north of Tokyo, the cycle is largely two years, and in the years of beetle abundance they may be found from early July to September, whereas during the alternate years they disappear either before or shortly after August first, thus covering a period of less than one month. These points are mentioned because they have an important bearing upon the development of certain of the parasite species.

Several other species of *Popillia* occur in Japan, but they are extremely rare. In Korea three species are found, *Popillia atrocaerulea*, *bogdanowi*, and *indigonacea*, these being given in the order of their appearance during the season. None of these are of any importance economically.

Of the parasites of *Popillia japonica* those of the adult beetles may first be mentioned. These are: *Centeter cinerea*, a new genus and species recently described by Dr. Aldrich, *Ochromeigenia ormioides* Towns. and *Eutrixa* sp., all Tachinids. The first is found only in the northern sections of Japan under climatic conditions corresponding closely to those of New Jersey. In the areas mentioned this Tachinid is always found, and usually in considerable abundance. One generation is produced each year, the adults appearing somewhat prior to those of the host. The parasitism of female beetles at Sapporo in 1920 and 1922 exceeded 99 per cent, and this within two weeks after the emergence of the beetles. As many as fourteen eggs were found on a single beetle in the field, and of all eggs laid from 70 to 99 per cent were upon female beetles. During the alternate years, 1921 and 1923, the parasitism was slightly less than 50 per cent, with between 98 and 100 per cent of the eggs on female beetles. This biennial rise and fall is closely

correlated with the largely two year cycle of the host. At Koiwai, where the beetle is fairly abundant each year, the parasitism ranges from 75 to over 90 per cent, as based on four years observations. During the past three seasons a total of 296,000 parasitized beetles have been collected, as many as 56,000 having been secured in a single day, and the puparia from these shipped to New Jersey.

Ochromeigenia ormioides is found more or less commonly only in the warmer sections, particularly at Yokohama, where in 1922 a parasitism of approximately 35 per cent was secured. Unlike *Centeter*, this Tachinid is nocturnal, deposits living larvæ rather than eggs, and has a life cycle of about 20 days, thus permitting nearly three full generations per year. This parasite was originally described from Java, and has since been found also in western China, Manchuria and Korea. It attacks several species of *Anomala* as well as *Popillia*. A number of shipments have been made, but thus far without success.

The third Tachinid upon adults, *Eutrixa* sp. was first secured during the past season from a shipment of *C. cinerea* material forwarded to the Riverton laboratory in 1922. It is comparatively rare, and of much less value in Japan than either of the previously mentioned species.

Of the parasites of *Popillia* grubs in Japan 3 species were found, one being a Dexiid fly and the remaining two of the Scoliid genus *Tiphia*. One of the latter occurs at Yokohama during July and early August and has not been considered for importation, due to its unfavorable time of appearance. The second was found abundantly only at Koiwai, where a field parasitism of about 20 per cent was effected during late August and early September. Shipments of reared cocoons totaling 3,350 have thus far been sent over.

The Dexiid parasite (*Prosena siberita* Fabr.) occurs commonly throughout Japan and in Korea as well, and effects a field parasitism of approximately 10 per cent. This species deposits its larvæ on the surface of the soil, and these burrow about in search of grubs within which to develop. One generation per year is produced. Shipments of parasitized grubs totaling 10,600 have thus far been forwarded to New Jersey. A potential rate of increase of 500 fold per year, in addition to a high degree of adaptability as regards climatic and soil conditions, would indicate the possibility of greater effectiveness under American conditions.

Only one predator has been considered for importation, this being a Carabid (*Craspedonotus tibialis*) which was found abundantly in certain sandy regions. Some 17,000 adults of this species were collected and

forwarded, but apparently were unable to survive under the changed conditions.

In Korea during the past two seasons 5 species of parasites on related *Popillia* have been found, and these have been shown experimentally to develop equally well upon *P. japonica*. Three of these are *Tiphia*, one being fairly common in restricted localities in late May and early June, while the first of the fall species is abundant in late July and early August. The normal host of the latter species is *Anomala*. The third species of *Tiphia* is very rare and occurs during late September.

The past season one species of *Campsomeris* has been found in Korea, this developing equally well on grubs of either *Anomala* or *Popillia*. One generation is produced each six weeks, and consequently the value of this Scoliid against *P. japonica* in America is dependent upon the presence of some alternate host on which the midsummer generation may develop.

One Dexiid (*Dexia* sp.) was found parasitic upon *Popillia* and other grubs in Korea and, unlike the Japanese species, has three full generations each year. From our observations on this as well as other species of Dexiidae it appears probably that most, if not all, members of this group which parasitize Scarabaeids are able to pass through the latter larval stages, and pupate, only in grubs which are themselves undergoing histolytic action preparatory to pupation. It is for this reason that the Korean Dexiid has a different host for each generation. The value of this parasite under New Jersey and Pennsylvania conditions is therefore dependent upon the presence of additional hosts which pupate at the required time. The rate of increase of this species will consequently be controlled largely by the numerical abundance of these alternate hosts, if such are available.

In summarizing the work in Japan and Korea during the past four years it may be stated that eleven species of parasites have thus far been found which normally do or can develop on *P. japonica*, three of these being upon adult beetles and the remaining eight upon or in grubs. With the exception of one *Tiphia*, all of these have been or will be introduced in numbers sufficient to establish them if such is possible. In general the outlook is very encouraging, and if an effectiveness equal to that in the native home of *P. japonica* is secured it should go far towards reducing the ravages of the beetle. A period of years will be required however, before full developments will actually reveal to what extent this hope is justified. The progress achieved in the colonizing of these various species will be reported on from time to time by the staff of the Bureau laboratory at Riverton, New Jersey.

PRESIDENT A. G. RUGGLES: The next paper is by P. A. Readio.

NOTES ON THE LIFE HISTORY OF A BENEFICIAL REDUVIID, *SINEA DIADEMA* (FABR.), HETEROPTERA

By P. A. READIO, *University of Kansas, Lawrence, Kansas*

ABSTRACT

Sinea diadema (Fabr.) is a predacious insect which, because of its wide distribution on our continent, its richness in individuals, and its diet of injurious insects, is of considerable importance as a beneficial insect. It winters as an adult and probably passes through two generations a season. Description of the eggs, the process of hatching, feeding of the nymphs, length of the nymphal stages and descriptions of the nymphal instars are given in this paper.

When one is collecting in fields and meadows, the very common occurrence of a medium sized, grayish-brown, spiny reduviid frequently causes speculations as to whether this very abundant species, *Sinea diadema* (Fabr.), is not of great benefit as an enemy of the injurious insects found in the same fields. A continuation of these speculations led to the following study.

In the first place, *Sinea diadema* is a species of very wide distribution in North America. Van Duzee[1] mentions its occurrence in twenty-one states of the United States and in two provinces of Canada. Uhler, speaking of *Sinea diadema*, says, "It is distributed over a large part of North America from Mexico into Canada, and throughout the Atlantic region,"[2] and again, "The species is common in many parts of North America including California, Mexico and Central America."[3] There can be no doubt of its general distribution on our continent.

We also find that *Sinea diadema* is, in a good many localities, rich in individuals. Torre Bueno, speaking of this species, says, "A common species on red clover. It is, perhaps, the commonest species in the East."[4] In eastern Kansas the writer has found it to be very common indeed in all grassy and weedy fields and in alfalfa. Most of the faunal list of Heteroptera of North American regions record *Sinea diadema* as "common."

If, now, we can add to the wide distribution and the richness in individuals a diet of injurious insects we shall have a beneficial insect of no small importance. That this is true seems to be the case. Torre Bueno says, "It preys on caterpillars and other soft bodied insects which it catches on the clover."[4] Chittenden mentions it as a natural enemy of the Colorado potato beetle[5] and of the striped cucumber beetle.[6] Morgan found that it would feed on the cotton boll weevil and the pepper weevil, consuming larger numbers of these insects than

another reduviid, *Apiomerus spissipes*,[7] with which he was working. Ashmead says of it, "The crowned Soldier Bug (*Sinea diadema*) was common in all the cotton fields visited and does great service in destroying the cotton aphids, small caterpillars, including the cotton worm, and other injurious species."[8] The writer has fed this insect on a wide variety of lepidopterous larvæ, plant lice, leaf hoppers, small grasshoppers, the tarnished plant bug and other mirids, weevils, small leaf beetles and many other injurious insects. It is also true that it is found commonly in the fall of the year on golden rod, feeding on flies and bees. The writer has come to the conclusion that *Sinea diadema* is a generally beneficial species, of outstanding importanc as an enemy of no particular species, but nevertheless doing a vast amount of good in the wide range of its distribution.

Seasonal Life History

Sinea diadema winters as an adult, as do so many other Heteroptera. Adults have been taken in late November in the winter rosette of common mullein, *Verbascum thapsus*.

There are probably two generations a season. This study was begun in the middle of June, and at that time adults and nearly grown nymphs, but no young nymphs, were collected in the field. The adults mated almost immediately and laid eggs soon after. Collecting in July produced adults and nymphs of all stages, probably nymphs of the second generation. From this, the writer concludes that there are two generations, the first maturing in June and early July, and the second maturing in August and early September and wintering over.

Details of Life History

Eggs: The eggs are laid in double rows on stems or leaves of plants, or on other objects, in groups of from five to twenty-two, the usual number being from eight to twelve. They are attached by means of a glue. The largest total number of eggs laid by a single female in the laboratory was four hundred and twelve; these were laid over a period of two months. The eggs have been figured by Heidemann[9] and Barber,[10] and described by Heidemann, Ashmead[8] and Barber. I quote the description given by Barber.

"Length 1.3 mm.; width .6 mm.; diameter of extension of chorion .8 mm. Color brown, minutely granulated, somewhat shining; central area of cap brown, outer rim brown with minute, regular, white reticulations; extension of the chorion white with dark lines, brown towards the inner edge; shape, subelliptical, narrowed towards the cap; central area of the cap raised, cone-like, bluntly rounded at the tip, composed

of several scales which fail to meet at the tip; outer rim of the cap flat with minute, regular reticulations; extension of the chorion on the same plane with the outer rim of the cap in new laid eggs, after hatching or drying bending upwards or downwards, squamous, minutely so towards the inner border, gradually coarser outwards, edge sinuate; chorial processes numerous, elongate, club-shaped, within the extension of the chorion."

When the egg leaves the body of the female the fringe-like collar is folded up with the scales erect as is the bud of a flower, and forms a button-like knob on the top of the egg. Upon drying, however, the collar expands and takes a horizontal position as described above. This process of expansion, at least under the heat of a microscope lamp, requires less than a minute.

Hatching: In from ten to fourteen days after being laid the eggs hatch. Stages in incubation and appearance of eye spots can not be seen because of the opaque shell.

In hatching, the insect tilts the cap off and emerges slowly, requiring about two minutes for the operation. The young insect appears to be folded once upon itself and the top of the thorax appears first. The membrane of the post-natal molt is broken through and the body and appendages slowly freed. The legs, antennae and beak are folded up together and are extricated by repeated pulls, first on the hind legs, then the middle legs, then the front legs and finally the antennae. At each pull a slight advantage is gained. When nearly cleared, the appendages are bowed out to the sides and a little additional leverage gained in this way. The short, middle legs are freed first, the hind legs next, and the long front legs and antennae last. When the appendages are all free the insect remains for a short time attached to the shell by the tip of the abdomen only, apparently waiting for the legs to become hard enough for use. Then it catches hold with its legs, easily frees the abdomen from the post-natal membrane, and stalks off. The cap of the egg frequently catches on one of the spines on the thorax and adds something to the already grotesque appearance.

Feeding of Nymphs: After hatching, the nymphs were isolated in stender dishes, given a bit of stick to rest on, and fed daily. The smaller nymphs were fed plant lice, tender leaf hopper nymphs and very small caterpillars. Older nymphs were fed adult leaf hoppers, larger caterpillars, mirids, and various other insects. It was observed that ants and lady bird beetles were not attacked if there were other insects present that could be fed on. The nymphs, and adults as well, were canabalistic to a certain degree, but they seemed to prefer other species when they could get them.

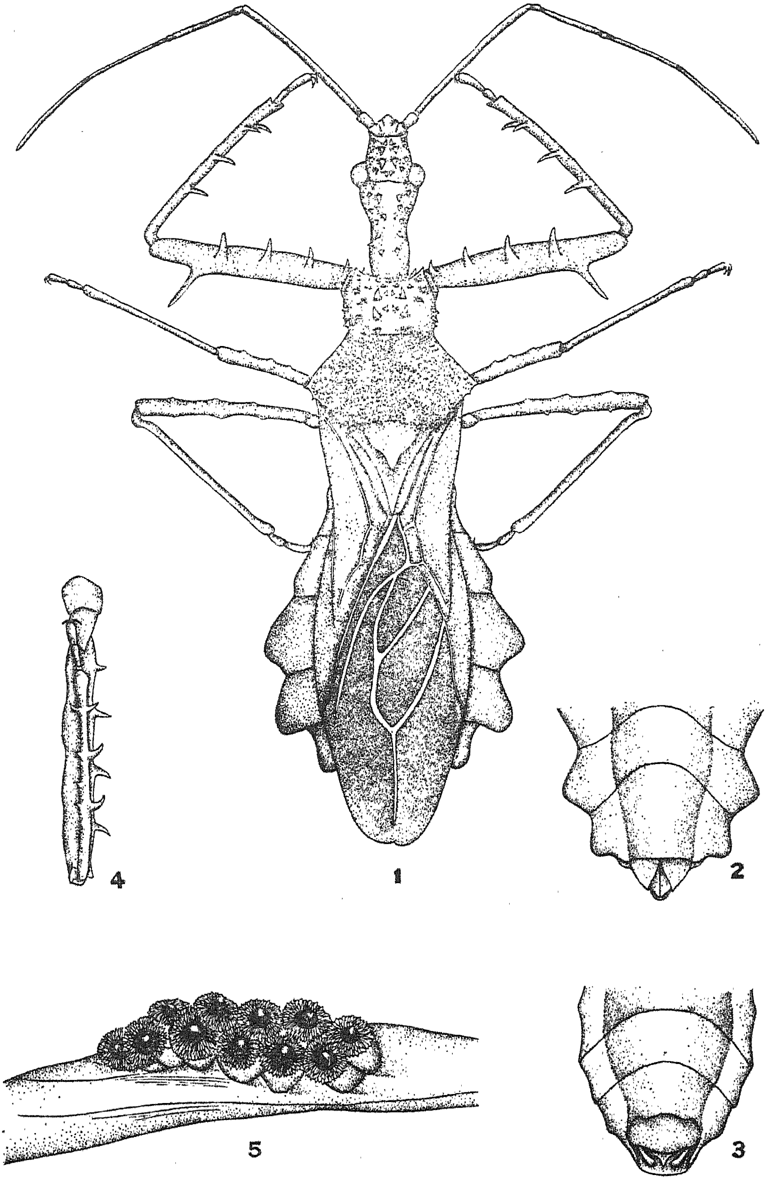

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Fig. 1—*Sinea diadema*. 1. adult female. 2. Ventral view of female abdomen. 3. Ventral view of male abdomen. 4. Grasping front leg. 5. Group of eggs.

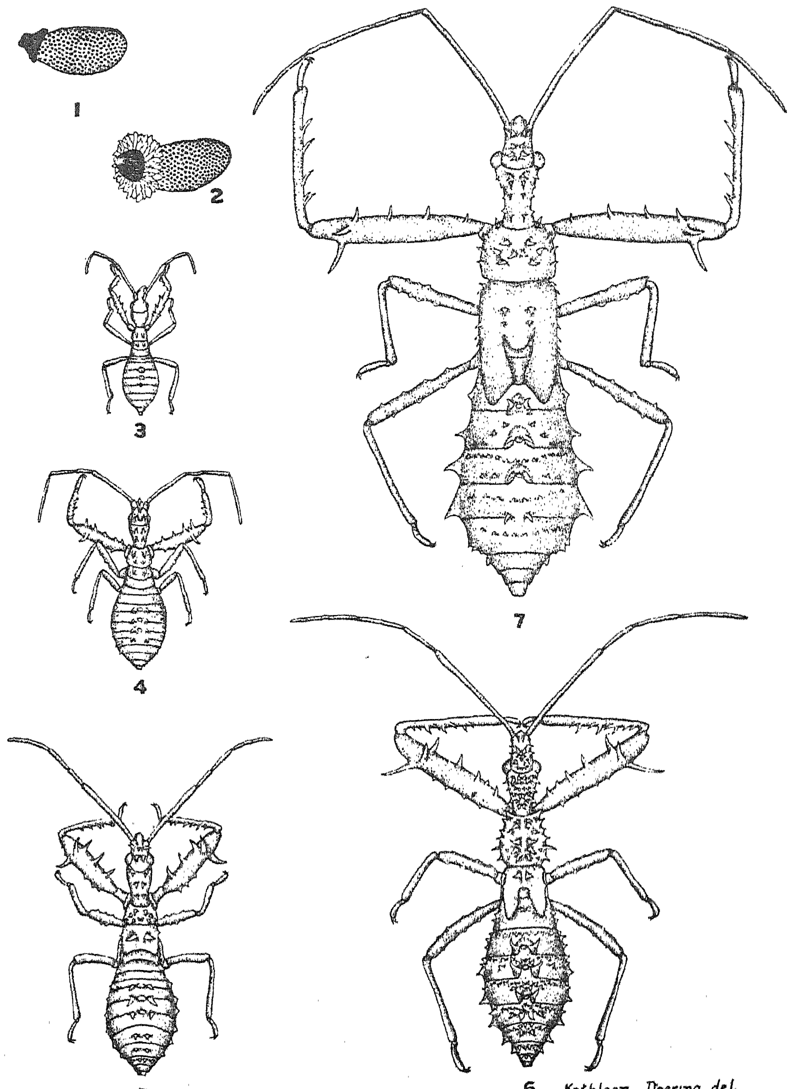

Fig. 2—*Sinea diadema*. 1. Egg before drying. 2. Egg after drying. 3. First instar. 4. Second instar. 5. Third instar. 6. Fourth instar. 7. Fifth instar.

LENGTH OF STAGES: In the insects reared, the first stage lasted from five to eight days, with seven days as an average for thirty-four individuals.

The second stage lasted from four to nine days, with seven days as an average for nineteen individuals.

The third instar lasted from four to eight days, with six and one-half days as an average for thirteen individuals.

The fourth instar lasted from six to sixteen days, with nine days as an average for nine individuals.

The fifth instar lasted from eight to fifteen days, with twelve and one-half days as an average of seven individuals.

DESCRIPTION OF INSTARS

The newly hatched nymphs have been described by Ashmead[8] and by Barber,[10] but as these descriptions do not fit older individuals in the first stage in all particulars, they have been modified. Former descriptions of the other instars have not been found and are included here.

FIRST INSTAR: Range in length 1.8 mm. to 2.5 mm.; length of first antennal segment, .7 mm.; length of front femur .9 mm. General color dark; head, bases of antennae, top of thorax, front femora and tibiae, and middle region of abdomen black; remainder of antennae, front tarsi, and entire middle and hind legs brownish; lateral margins of dorsum of abdomen dirty white, especially anteriorly, eyes red. Location of spines as follows: Head, none; prothorax, one erect pair, and antero-lateral angles pointed; mesothorax, one erect pair; abdomen, none; front femur, two ventral rows, one dorsal row, and a single preapical spine on the inner side; front tibia, two rows on the under side. Openings to dorsal stink glands located in anterior portion of abdominal segments four, five and six, location marked by dark plates, unarmed in this instar.

SECOND INSTAR: Range in length 2.9 mm. to 3.6 mm., length of first antennal segment 1.1 mm., length of front femur 1.2 mm. General color dark, though slightly lighter than in the preceding instar, distribution of color as in the preceding instar. Location of spines as follows: Head, two large pairs and several smaller pairs; prothorax, one large pair and several smaller pairs on dorsum, sides spiny; mesothorax, one large pair; metathorax, none; abdomen, one pair on each of the dark plates on adbominal segments three, four and five, and an additional pair in a corresponding position on segment six; femur and tibia as in preceding instar. Openings to dorsal stink glands located in anterior portion of segments four, five and six; location marked by plates on the posterior portion of the segment preceding the opening, each plate being armed with a pair of erect spines.

THIRD INSTAR; Range in length 4.7 mm. to 5.1 mm.; length of first antennal segment 1.5 mm., length of front femur 1.9 mm. General color much lighter than in the preceding instar, tawny, mottled, fairly uniform, with head, bases of antennae, top of thorax, front femora and three plates on dorsum of abdomen slightly darker than the

other parts. Location of spines as follows: Head, three pairs of large spines and several smaller ones cephalad of transverse suture, one pair of large spines and several smaller ones caudad of transverse suture; prothorax, two pairs of large spines, the anterior one of which is branched at the base, and many smaller spines on the dorsum and pleurae; mesothorax, one large pair present on dorsum and several smaller spines on pleurae, metathorax, one small pair on dorsum and several smaller spines on plsurae; abdomen, spines present as in the preceding instar with the addition of small spines on the dorsal surface and at the lateral edges of the abdominal segments. Wing pads first appear in this instar, extend only to first abdominal segment. Openings of dorsal stink glands as in the preceding instar.

FOURTH INSTAR: Range in length 6.7 mm. to 7.7 mm., length of first antennal segment 2 mm., length of front femur 2 mm. General color tawny to darker, mottled. Location of spines as follows: Head, three pairs of large spines and several smaller ones cephalad of transverse suture, three pairs of large spines and several smaller ones caudad of transverse suture; prothorax, very spiny, with many large spines on dorsum, and smaller spines on both dorsum and pleurae; mesothorax, one large pair on dorsum and several smaller spines on pleurae; metathorax, as in preceding instar; abdomen, as in the preceding instar with an increase in the number of spines on the dorsal surface; front femur, as in preceding instars except that basal spines in dorsal row are becoming obsolete, the apical spine alone now being well developed. Wing pads now extend over second abdominal segment.

FIFTH INSTAR: Range in length 8.8 mm., to 10.4 mm: length of first antennal segment 3.3 mm., length of front femur 4 mm. General color light tawny, mottled. Location of spines as follows: Head, as in the preceding instar but spines are longer, prothorax, very numerous, long, conspicuous, present both on the dorsum and on the pleurae; mesothorax, one large pair, one medium pair, and several smaller pairs present on the dorsum and many others on the pleurae; metathorax, many spines on the pleurae; abdomen, as in the preceding instar with an increase in the number of spines on the dorsal surface. Wing pads now extend over third abdominal segment.

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PRESIDENT A. G. RUGGLES: We will now listen to a paper by Alvah Peterson.

SOME CHEMICALS ATTRACTIVE TO ADULTS OF THE ONION MAGGOT, (*HYLEMYIA ANTIQUA* MEIG.) AND THE SEED CORN MAGGOT (*HYLEMYIA CILICRURA* ROND.)[1]

By Alvah Peterson

Abstract

The adults, males and females, of the onion maggot, *Hylemyia antiqua* Meig. and the seed corn maggot, *Hylemyia cilicrura* Rond. are attracted in large numbers to sweetened baits containing small amounts (1–2 drops to 5 cc.) of several alcohols, particularly allyl alcohol, iso propyl alcohol, ethyl alcohol and butylic alcohol. Allyl alcohol and iso propyl alcohol were the most attractive. These alcohols mixed with honey and water as a medium were most attractive.

Sweetened media, particularly molasses, honey or brown sugar, containing yeasts (made with wet yeast, "Fleischmans Yeast" or dry yeast, "Magic Yeast" or "Yeast Foam") also proved to be highly attractive to both species of flies.

The baits containing alcohols lost their attractiveness as soon as the alcohol evaporated. This usually occurred 24 to 48 hours after they were placed in the field. Baits containing yeasts remained attractive 14 to 21 days or longer provided they were not allowed to become dry.

Sodium arsenite added to baits containing alcohols in amounts as large as ¼ ounce to 1 quart of bait did not bring about a perceptible change in the attractiveness of the bait while this amount of sodium arsenite added to yeast baits apparently killed the yeast organism for there was a marked diminution in the attractiveness of the bait, particularly with yeast baits made from dry yeast. In a number of experiments, where sodium arsenite was used, at the rate of ¼ ounce to 5 quarts of the bait, especially where wet yeast was employed, the attractiveness of the bait was not materially reduced. Further experiments may show that very small amounts of sodium arsenite (sufficient to kill the flies) may be added to sweetened yeast baits without dimininishing the attractiveness of the bait.

Introduction

During the spring and early months of 1923 the author investigated the chemotropic response of the adults of the onion maggot, *Hylemyia antiqua* Meig., and the seed corn maggot, *Hylemyia cilicrura* Rond., to numerous odors. He is indebted to Dr. T. J. Headlee for this opportunity. Those odors which attracted flies were more thoroughly studied than those which repelled. This preliminary report summarizes the information ascertained to date. No attempt is made to prove by extensive tables or graphs the facts presented. Further study is desirable and a larger publication is needed before a satisfactory and complete presentation of the information can be made. It is hoped that some of the information contained in this summary may be useful to investigators who are interested in the development of a control measure for these pests.

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Adult flies of *Hylemyia antiqua* Meig. and *Hylemyia cilicrura* Rond. were found in the fields in the southern part of New Jersey early in March and they continued to be present in small or large numbers during April, May and June. This investigation ended June 30, 1923. Most of the experiments which are discussed in this report were conducted during May and June. Early in May and again after the middle of June *Hylemyia antiqua* Meig., was the most abundant species while late in May and early in June adults of *Hylemyia cilicrura* Rond., occurred in large numbers. In the majority of the collections and catches of *Hylemyia cilicrura* Rond. the males outnumbered the females but with *Hylemyia antiqua* Meig., the females equalled or outnumbered the males. A more thorough investigation is needed to determine definitely the above facts. The past season's experience convinces the author that wherever a chemotropic study is made it is important to have complete information on the abundance of the species and the normal proportion of the sexes of each species in the territory during the entire period of the investigation.

Methods

Several methods and apparatuses were used to catch and determine the flies which were attracted to odors. After a number of preliminary trials a small round wire screen (12 meshes to the linear inch) fly trap was adopted as the most satisfactory trap for catching the flies. It is probable that a wire screen trap of finer mesh (16 to 20 meshes per linear inch) would be more satisfactory. In some instances the smallest individuals of *Hylemyia cilicrura* Rond., were able to work their way through the 12 mesh wire-screen. The round trap used was 9 inches high, 6 inches wide at the bottom and 4 inches wide at the top. The top of the trap was a solid piece of tin with a small handle attached. A detachable round wire-screen cone approximately 4 inches high and with a small round hole near the top fitted snugly within the bottom of the upright portion of the cage. The entire cage including the cone was clamped to a tin base and it could be easily detached from the base. Under field conditions a long iron spike (six inch nail) was driven through the center of the bottom into the ground below and served as an anchor for the cage. When properly anchored high winds and beating rains did not upset the cages. The bait was placed in a Syracuse watch glass on top of the tin base and directly below the hole in the cone. In the field the traps were placed between the rows of onions and 25 to 50 or more feet apart.

The flies of *Hylemyia antiqua* Meig., and *Hylemyia cilicrura* Rond. have the habit of flying low and near the ground. When resting they are found on the ground or on low vegetation. The traps used were suited to this ground habit of the flies. The point of entrance for the flies into the trap was a narrow slit (¼ to ½ inch wide) about the entire bottom between the tin base and the wire-screen cage. The flies of both species are attracted to light, positively phototropic, and they also have the habit of crawling upward. The upward crawling habit may be due to positive phototropism. After the flies were once below the rounded cone they usually fed on the bait and then in flying away from the bait they usually came to rest on the inner portion of the cone. They then crawled upward and through the small round hole at the top of the cone. Once within the upper part of the cage they did not escape.

The cages were examined at different time intervals depending upon the nature of the experiment. In some cases 12 or 24 hours apart and in other instances as many as 7 days apart. It was found that 75 to 100 cages was the maximum number one man could properly handle in one day. Whenever the cages were examined for the results of the experiments, the total number of adults of *Hylemyia antiqua* Meig. and *Hylemyia cilicrura* Rond., were counted and properly recorded and then the flies were removed at once. By proper shading with a dark cloth and inverting the detachable cone of the cage the flies were induced to enter small glass bottles where they were killed with chloroform. After they were dead all of the Diptera found in one cage were placed in small tin pill boxes and carefully labeled with an accession number and date of collection. The flies were kept in the tin boxes in a dry place free of museum pests until the author had time to determine definitely the species and sex of each. Flies have been kept in this way for almost a year and they have been satisfactory for determination. The majority of the flies in the cages proved to be adults of *Hylemyia antiqua* Meig., and *Hylemyia cilicrura* Rond., during the period of this investigation.

In making use of numerous concentrated oils and solutions that are highly odoriferous it was necessary to use some medium for diluting them. Several products were tried such as water, water solutions of several sugars, (cane, brown, maltose, lactose and dextrose), corn syrup ("Karo," brown and white), molasses and honey. In all the experiments where a medium was used a check was included to determine the attractiveness of the medium by itself. In some respects corn syrup proved to be the most satisfactory medium. It has little or no attrac-

tion for the flies, evaporates slowly when diluted with water and with most of the chemicals employed no change took place between the medium and the odoriferous chemical. The chief objection to corn syrup was the fact that a resistant skin-like film forms over the liquid product upon exposure to hot sun and dry weather for several days. Brown sugar diluted with water, molasses and honey were useful media in many cases. In fact larger catches of flies often were made with these media than with corn syrup because they are attractive to flies by themselves. This was particularly true of honey. One teaspoonful of the medium was placed in a Syracuse watch glass and about three teaspoonfuls of water added. This nearly filled the dish. To the diluted medium the odorous agent was added. In case the agent was a liquid 5 drops (amount most frequently used) were added and thoroughly mixed with the medium. If the agent was yeast a piece the size of a small pea was most frequently added. Where pieces of onion were used ½ to 1 bulb (sliced) of a small green onion or a half dozen 1 inch lengths of a green leaf were added.

The following odorous products and poisons were given one or more trials by themselves (in media) and in some cases in combination with each other: Oil of hemlock, sassafrass, pineneedles, spruce, nutmeg, cinnamon, mustard (true and artificial), phenyl mustard oil, orange, lemon, cloves, menhaden, camphor, anise seed, oleoresin capsicum (pepper), peppermint, spearmint, rose geranium, fusel and peach kernels; also formic acid, acetic acid, butyric acid, lactic acid, valeric acid, ammonia, formaldehyde, aldehyde, (ethylic acetic) creososte, linalyacetate, acetone, amylacetate, allyl sulfide, allyl bromide, allyl iodide, allyl alcohol, milk (sweet, sour and powdered), dry compressed yeast ("Magic Yeast" and "Yeast Foam") and wet yeast ("Fleischman's Yeast"), onion (bulbs and tops), sodium arsenite, mercuric chloride, sodium fluoride, sodium cyanide, nicotine sulfate, hellebore, and extracts of derris.

Discussion

Many and interesting observations will be omitted from this report. Only those points will be discussed which bear directly on the problem under discussion.

The adult flies of *Hylemyia antiqua* Meig., and *Hylemyia cilicrura* Rond., are most active on warm dry days in the early hours of the morning and toward evening, at least the great majority of the adults came to the cages during these hours. Cages placed in irrigated fields (overhead irrigation) usually did not catch as many flies as cages in open dry

fields. This may be due to the fact that the flies in wet fields readily secure sufficient moisture to satisfy their thirst, consequently wet baits are not so attractive in wet fields as in dry fields.

At the outset a number of traps were run to determine the attractiveness of water diluted solutions of brown sugar, molasses, honey, corn syrup, cane sugar, maltose, lactose and dextrose. The first three products attracted a moderate number of flies while the last five substances attracted few or no flies. Honey, as a rule, was the most attractive. In connection with the tests on the attractiveness of the media, additional traps were run with the respective media where parts of young onion plants were added. In most cases slices of the bulb portion was used while in a few tests pieces of green onion tops (leaves) were employed. There was little or no difference in the attractiveness of the onion bulb or onion tops. In a few cases the baits containing pieces of onion tops attracted a few more flies than the baits containing slices of the bulb portion. As a rule the addition of pieces of growing onions to most of the media increased the attractiveness of the bait about twice for both species. In a few cases 3 to 5 times as many flies were caught in the traps where parts of an onion were added as in the checks (media and water alone).

An examination of the list of substances tried shows a number of essential oils and closely related products. All of these were given at least three trials using corn syrup and other media. The majority had little or no attraction for the flies of either species. Oil of nutmeg, oil of peach kernels, clove oil, true mustard oil and fusel oil gave some indication of being attractive in some of the trials. They were primarily attractive to *Hylemyia cilicrura* Rond. In the majority of the tests these oils attracted 4 to 6 times as many flies as the check trap (medium plus water).

In conjunction with the study of essential oils several allyl products were tried; allyl sulfide, allyl iodide, allyl bromide and allyl alcohol. The chief reason for giving these products a test was due to the fact that it has been shown by several investigators that the odor of the onion is an allyl product, probably closely associated with allyl sulfide. In quite a large series of field tests with the allyl products named in different media and under varying outdoor conditions allyl alcohol was the only allyl product which was attractive. This substance in most cases was highly attractive to both species of flies. In numerous instances the presence of allyl alcohol attracted, 5, 10 and in some cases 15 or more times as many flies as the media by itself. Some media with allyl

alcohol were much more attractive than others. This was true of honey and corn syrup. For some unknown reason allyl alcohol mixed with water solutions of brown sugar or molasses were not as a rule very attractive.

Upon learning that allyl alcohol was so decidedly attractive the author turned his attention to a study of a number of the alcohols. The following were tried; allyl alcohol, iso propyl alcohol, ethyl alcohol, butylic alcohol, amyl alcohol and methyl alcohol. In a number of repeated trials with different media the first five alcohols named proved to be more or less attractive for both species. They are named in the order of their attractiveness. Methyl alcohol and in some instances, amyl alcohol had no attraction for the flies of either species. As a rule the alcohols were most attractive when combined with honey as a medium. After a few experiments with the attractive alcohols in the field it was soon discovered that baits containing these alcohols soon lost their attractiveness. This is undoubtedly due to the complete and rapid evaporation of the alcohol when placed in the hot sun and dry winds. In most cases baits mixed with alcohols did not attract flies after 48 hours and in some cases failed to attract after 24 hours. In an effort to find some means whereby the attractiveness of the bait could be continued over a longer period of time by maintaining a constant and new supply of alcohols the author thought of fermentation which might be brought about by yeasts. A large number of tests were made with yeasts in combination with the several media and in most instances the baits containing yeasts proved to be very attractive to both species of flies. Furthermore the yeasts continued to develop the attractive odors and in some instances the baits containing yeasts continued to attract flies for two and three weeks provided water was present.

Two kinds of yeast were experimented with, a hard compact dry yeast ("Magic Yeast" or "Yeast Foam") and a compressed wet yeast ("Fleichman's Yeast"). Small pieces (about the size of a small pea) of the respective yeasts were added to each dish of the different media employed and within 12 to 48 hours decided gas production was observed in the dishes. As soon as the fermentation odors came off the flies of *Hylemyia antiqua* Meig., and *Hylemyia cilicrura* Rond., usually came to the traps in large numbers. Yeasts mixed with water solutions of molasses, honey or brown sugar proved to be the most attractive while yeasts combined with water solutions of corn syrup or cane sugar were least attractive. The dry yeast baits usually required a longer

time, 24 to 48 hours, to become attractive but after fermentation started the baits made with dry yeasts often remained attractive over a longer period of time than those made with the wet yeast. In a number of cases the baits with dry yeasts attracted many flies 14 to 21 days after they were placed in the field provided there was sufficient moisture present in the dishes. The wet yeast in some instances proved to be attractive almost from the start when mixed with some of the media.

Baits containing yeasts usually attracted many more flies over a period of seven days or longer than any of the alcohols mentioned above. In some cases the alcohol baits caught as many and more flies the first 48 hours as the yeast baits but after the alcohol evaporated they were no longer attractive.

It is the opinion of the author that the baits containing yeast were attractive because of the alcohols and ethereal odors produced in fermentation. It is possible that carbon dioxide given off in fermentation might play some part as an attractive agent. This is a point which needs further investigation. After discovering the attractiveness of several alcohols and fermentation odors produced by yeasts a study was made of the effect of adding stomach poisons to the baits containing the attractive agents. Sodium arsenite was most extensively used. When sodium arsenite in moderate amounts (¼ ounce to 1 quart of media) was added to the baits containing the alcohols there was little or no perceptible change in the results while the addition of sodium arsenite (½ ounce to quart of media) to baits containing yeast organisms there was a marked diminution in the attractiveness of the bait. This was undoubtedly due to the influence of the arsenical on the yeast organism. Sodium arsenite seemed to have the greatest effect on the results obtained where dry yeast was employed to bring about fermentation. The wet yeast organism withstood and seemed to function better than the dry yeast organism in the presence of sodium arsenite. In a number of instances where sodium arsenite was used at the rate of ¼ ounce to 5 quarts of media with wet yeast the attractiveness of the bait was not materially reduced. Further study is needed to determine the maximum amount of sodium arsenite which may be used without reducing the fermentation process.

Other stomach poisons were given a few trials; such as mercuric chloride, formaldehyde, sodium fluoride, sodium cyanide, nicotine sulfate, hellebore and extracts of derris. Mercuric chloride and formaldehyde killed the yeast organisms as expected. The other stomach poisons did not necessarily kill the yeast organisms but in most of the tests

there was a reduction in the attractiveness of the bait when the poisons were added in small amounts. Further experiments are needed to determine the most desirable and practical stomach poisons, the minimum dosage of each and the influence the stomach poisons may have on bait containing alcohols or yeast organisms.

In the course of the investigation a number of other products named in the list were tried. Each was given several trials. Of these agents amyl acetate, acetone, acetic acid and milk (wet powdered milk and sour whole or skim milk) proved to be fairly attractive in some instances while in other trials they attracted few if any more flies than the checks.

Summary

To the author the most interesting result in this study was the positive chemotropic response of the adults of *Hylemyia antiqua* Meig., and *Hylemyia cilicrura* Rond., to the odors coming from several alcohols, particularly allyl alcohol, iso propyl alcohol, ethyl alcohol and butylic alcohol and odors from fermentation by yeasts when mixed with sweet substances such as honey, molasses, brown sugar, corn syrup etc.

Baits containing alcohols remained attractive for a short period (24 to 48 hours) only while the baits containing yeasts remained attractive for 14 to 21 days or longer provided they did not become too dry.

Sodium arsenite in small quantities did not influence the attractivenes of the baits containing the several attractive alcohols but it did influence the attractiveness of baits containing yeasts, particularly baits made from dry yeast. It seems probable that a small amount of sodium arsenite may not influence the attractiveness of baits made with wet yeasts and this amount may prove to be of sufficient strength to kill the flies.

Acknowledgments. The author is indebted to Dr. T. J. Headlee for the opportunity of carrying on this investigation. He also wishes to thank Dr. J. M. Aldrich of Washington, D. C., and Dr. H. C. Huckett, of Riverhead, N. Y., for help in identifying the species of flies caught in the traps.

President A. G. Ruggles: We will now listen to a paper by Hugh Glasgow.

THE MERCURIC CHLORIDE TREATMENT FOR CABBAGE MAGGOT CONTROL IN ITS RELATION TO THE DEVELOPMENT OF SEED-BED DISEASES

By HUGH GLASGOW and W. O. GLOYER, *Geneva, N. Y.*

ABSTRACT

Rhizoctonia and some of the other common diseases of cabbage seed-beds are held in check by applications of mercuric-chloride solution as used in the control of the cabbage maggot, *Chortophila brassicae* Bouché.

The other two methods in common use for maggot control,—the cheesecloth screen and applications of tobacco dust,—appear to favor the development of such fungous troubles, especially during wet seasons.

Applications of mercuric chloride which give the most satisfactory control of the root maggot also appear best adapted to the control of the diseases studied. One very early application followed by one or two later applications at intervals of a week or ten days gave the best results.

Cabbage as grown commercially is subject to a number of serious diseases, some of which originate and are propagated in the seed-bed, and from here may be transferred to the field at the time of transplanting. Some of these diseases, while they have no direct connection with the work of the cabbage maggot, are nevertheless of interest in this connection since methods that have been advocated for the control of the maggot may, under certain conditions, have a profound influence on their development and dissemination.

Screening, for example, is perhaps the most efficient and without doubt the most generally accepted method for the protection of cabbage seed-beds from maggot attack. The cheesecloth screen serves admirably for this end, affording a great measure of protection from certain other insect pests as well as stimulating the plants to a more rapid growth. However, it has the weakness of increasing the liability to loss from certain pathogenic, soil-inhabiting fungi whose development and spread may be favored by the slightly higher temperatures and greater humidity found beneath such a screen.

Applications of tobacco dust also show a high degree of efficiency in preventing maggot injury as well as possessing other distinct advantages. Here, too, the development of these fungi appears to be favored, so that where outbreaks of such diseases are anticipated the use of tobacco dust in the seed-bed might well be of questionable value.

In our work with the cabbage maggot it has been observed for the past three or four years that the seedlings in different plats under treatment for maggot control showed a marked difference in susceptibility to certain common seed-bed diseases. Some of the treatments used,

while thoroughly effective in maggot control, actually increased the liability to loss from such fungous troubles, while others, notably mercuric-chloride solutions, very largely prevented the development of such diseases.

A number of seed-bed diseases have been under observation in the course of this work, but for the purpose of the present paper only Rhizoctonia will be considered as the data on this fungus are somewhat more complete and serve fully as well to illustrate the principle involved.

TABLE 1. RELATION OF DIFFERENT METHODS OF MAGGOT CONTROL TO THE DEVELOPMENT OF RHIZOCTONIA IN CABBAGE SEED-BEDS

Treatment	Number of applications	Number of plants examined	Percentage infested by maggots	Percentage infected by Rhizoctonia
Mercuric chloride 1–1200	1	162	33	19
"	2	182	11	4
"	3	230	3	3
Tobacco dust	1	242	34	83
"	2	346	2	89
"	3	218	0	79
Cheesecloth screen		158	0	66
Check	No treatment	1426	70	60

Rhizoctonia is a common damping-off fungus which, with cabbage, is primarily troublesome as a seed-bed disease; the young plants being attacked at or near the surface of the ground. At the time of transplanting the injured areas may appear as sunken, grayish-black lesions, which if extensive enough may girdle and cause the death of the plant; but more often result merely in a constriction or weakening of the stems. During some seasons this fungus may cause a high mortality among young plants in beds where conditions are favorable for the development of the parasite. While only a comparatively small percentage of the remaining plants may be actually killed, this weakening and dwarfing effect is often quite general. Table 1 represents one of a series of tests that have been made to determine the influence of the various methods in use for maggot control on the development of cabbage seed-bed diseases. In this particular instance the seed-bed was located in a rather low section of the field which had been planted to potatoes the preceding season. During the early development of the plants there was an excessive amount of rainfall so that taken as a whole conditions were unusually favorable for the development of this type of fungus.

Several methods were tried out in this particular case, but only the cheesecloth screen, tobacco dust and mercuric-chloride plats will be considered as the others have no particular significance in this connection.

The cheesecloth used for the screen was of a moderately coarse weave, averaging about 24 threads to the inch; the tobacco dust was a finely ground product, from 150 to 200 mesh, and containing one-percent nicotine; while the mercuric chloride was used at the rate of one ounce to ten gallons of water which gave a dilution of approximately 1–1200. The screen was applied about the time the young plants commenced to appear thru the ground and remained in place until shortly before transplanting. The tobacco dust and the bichloride solution were used at the rate of approximately one pound and one gallon respectively to thirty feet of row.

As may be seen from the results summarized in this table, even one application of the bichloride solution appears to have greatly decreased the number of diseased plants, while two or three successive applications reduced it to negligible proportions.

Tobacco dust, on the other hand, resulted in a tremendous increase in the infection not only as to the number of plants attacked, but under this treatment the lesions were much more pronounced than on the checks. The plants from this plat were characterized by the presence of abnormally large Sclerotia which in many cases completely encircled the stem. The Sclerotia were comparatively small or entirely absent on the check plants. Other characteristics of the tobacco-dust plats were the presence of a heavy weft of mycelium in the soil immediately about the plants and rather extensive edematous areas on the stems of many of the plants where the fungus was still active. These were also present in the check plats but to a much less degree, and were notably absent where the mercuric chloride solution had been used. It is evident that heavy applications of tobacco dust supply a medium in which Rhizoctonia and perhaps other parasitic fungi may develop much more readily than in untreated soils. It should be noted in this connection, however, that under ordinary conditions such applications stimulate the growth of the seedlings very appreciably and result in plants superior in size and quality to those produced by any other method.

In the screened plat the plants at the time of transplanting, should have been a week or more ahead of those grown in the open. For a time they did make a much more vigorous growth, but owing to the more favorable conditions for the development of the fungus beneath the screen this advantage was lost by the time the plants were one-half or

two-thirds grown. From this time on a considerable proportion of these remained distinctly dwarfed, and the difference between the screened plants and those grown in the open was more marked than is indicated by the counts. Many of the plants were dwarfed as a result of early infection, altho showing no well defined lesions at the time of transplanting.

The experiment recorded in Table 2 was one of a series carried out to determine the value of successive applications of mercuric chloride in

TABLE 2. RELATION OF TIME AND NUMBER OF APPLICATIONS OF MERCURIC CHLORIDE SOLUTION TO MAGGOT CONTROL AND TO THE DEVELOPMENT OF RHIZOCTONIA IN CABBAGE SEED-BEDS (MERCURIC CHLORIDE USED AT RATE OF 1 OUNCE TO 10 GALLONS WATER)

Plat	Row	Number of applications per row	Date of final application	Number of plants counted	Percentage injured by maggot	Percentage diseased
1	1	1	5–25	188	22.34	4.25
1	2	2	6–1	172	3.48	4.27
1	3	3	6–9	188	0.00	0.00
1	4	4	6–16	170	0.00	0.58
1	5	5	6–23	190	0.00	0.00
2	6	1	6–1	216	15.27	9.72
2	7	2	6–9	206	6.79	2.91
2	8	3	6–16	219	5.47	4.11
2	9	4	6–23	215	4.18	1.39
3	10	1	6–9	189	47.61	5.29
3	11	2	6–16	176	41.47	9.09
3	12	3	6–23	232	37.93	13.36
4	13	1	6–16	246	73.57	12.60
4	14	2	6–23	234	55.98	4.27
5	15	1	6–23	277	66.06	9.02
Check		No treatment		732	66.66	15.84

checking the development of Rhizoctonia in the seed-bed and needs but little explanation. The various plats were arranged and the different applications timed to give data bearing on the problem from as many different angles as possible.

Of the five applications to be put on at weekly intervals, the first was made one week after the plants commenced to appear thru the ground and included all five rows of Plat 1. The second application included the first and second plats except that Row 1 was omitted from Plat 1. In the case of the third application Plats 1, 2 and 3 were treated with the exception of Rows 1 and 2 of Plat 1 and Row 1 of Plat 2 which were

omitted. This operation was repeated at intervals of approximately one week until all five applications were made, one new plat being added and one row successively dropped from each of the preceding plats at each application. At the end of this five-weeks period, we therefore have fifteen different combinations bearing on the time and frequency with which each of the materials tested may be applied. The mercuric chloride, as in most of the other tests, was used at the standard concentration of 1 ounce to 10 gallons of water, the resulting solution being applied by means of a watering pot from which the rose sprinkler had

TABLE 3. RELATION OF TIME AND NUMBER OF APPLICATIONS OF MERCURIC CHLORIDE ACID SOLUTION TO MAGGOT CONTROL AND TO THE DEVELOPMENT OF RHIZOCTONIA IN CABBAGE SEED-BEDS (MERCURIC CHLORIDE ACID STOCK SOLUTION USED AT RATE OF 1 OUNCE TO 10 GALLONS WATER)

Plat	Row	Number of applications per row	Date of final application	Number of plants counted	Percentage injured by maggot	Percentage diseased
1	1	1	5–25	221	19.90	7.24
1	2	2	6–1	230	9.13	5.65
1	3	3	6–9	187	0.00	1.66
1	4	4	6–16	203	0.00	0.49
1	5	5	6–23	204	0.00	0.98
2	6	1	6–1	264	27.65	4.16
2	7	2	6–9	250	21.60	3.60
2	8	3	6–16	249	7.63	3.21
2	9	4	6–23	276	14.85	2.53
3	10	1	6–9	253	20.15	8.30
3	11	2	6–16	310	25.80	10.32
3	12	3	6–23	321	22.74	9.34
4	13	1	6–16	288	48.26	6.25
4	14	2	6–23	255	55.68	7.84
5	15	1	6–23	316	45–25	13.29
Check		No treatment		732	66.66	15.84

been removed so that the liquid could be directed along the row in a solid stream. The amount used in this case averaged about 1 gallon to from 20 to 40 feet of row, depending on the age of the plants, the quantity varying as the plants increased in size. This amount was found to moisten the soil about the plants to a depth of from ½ to 2 inches, depending on the physical make-up of the soil, the type of cultivation practiced and the moisture content. No attempt was made to reach to the entire depth of the root system in the older plants as this would have required an excessive amount of the solution. From this table it appears

that the timing of the applications which give the most satisfactory control of the root maggot parallels quite closely those which seem best adapted to prevent the development of Rhizoctonia. A very early application repeated once or twice at intervals of about a week seems to give the best results, while if these are deferred until later in the season the degree of control appears to be greatly lessened.

Table 3 is comparable in every way to Table 2 except that instead of a simple aqueous solution of mercuric chloride a stock solution was first prepared by dissolving the salt in concentrated hydrochloric acid. It was found possible by this method to prepare a stock solution which, for convenience in the field, was graduated so that one fluid ounce contained exactly one ounce by weight of the bichloride. It seemed possible that in addition to the convenience of such a concentrated stock solution, the slight amount of acid present might increase the insecticidal or fungicidal efficiency or at least improve the stability of the dilute solution. This has not been very evident so far in the field tests, but it seems probable that under certain soil conditions the slight amount of acid present might increase the efficiency of the solution. It should be added here that in field tests the acid solution does prove appreciably more toxic to the plants under treatment than where no acid is used.

While mercuric-chloride solutions seem to possess promise for the control of certain types of soil-infesting fungi, a word of caution may not be out of place. These solutions are not uniformly safe on all crops and under all soil conditions; for while some plants are quite tolerant to the treatment others may be seriously injured by heavy applications. Plants growing in extremely dry soils appear to be more liable to injury than where the soil is moist, and the reaction of a soil also has some bearing on the degree of safety. It is, therefore, not advisable to use the method indiscriminately until tests have been made to determine its safety for the crop which is to be treated.

The bulk of the experiments so far carried out have been with the standard solutions containing 1 ounce of the bichloride to 10 gallons of water. Preliminary tests with much greater dilutions seem to indicate that these also possess marked fungicidal properties when applied to the soil, and if these greater dilutions prove equally efficient the danger of injury to tender crops would be correspondingly lessened.

Just how wide an application this method will have, and what its relative value will prove to be in the control of different types of fungous diseases is by no means certain. It seems probable that its chief value will be for use against surface-infesting fungi or where it is merely a

question of carrying the plant over some critical period during which infection ordinarily takes place.

PRESIDENT A. G. RUGGLES: The next paper is by S. W. Frost.

FOUR YEAR EXPERIMENTS ON THE CONTROL OF THE RED-SPIDER

By S. W. FROST, *State College, Pa.*

ABSTRACT

General notes are given as to the status of the Red spider *Paratetranychus pilosus* C. & F., in Pennsylvania. Two methods of control, the delayed-dormant and summer applications are discussed. Miscible oils in the delayed dormant kill a large percentage of the eggs while lime sulphur has been found ineffective. Various types of sulphur spray during the summer have given satisfactory control while dusts have given little or no control.

The red-spider (*Paratetranychus pilosus* C. & F.) was first noted as a pest on apple trees in Adams county, Pennsylvania. Later it was found abundant throughout Pennsylvania and is now known to be common throughout the eastern part of the United States. During the past five years it has been more or less abundant according to seasonal conditions. Hot dry weather is very favorable for its development. During such summers an alarming amount of damage has been experienced. Cool rainy weather on the other hand, is unfavorable for its development and in fact heavy rains seem to wash them from the trees. Dr. H. E. Ewing believes that the species which inhabit low growing plants, as the raspberry, suffer considerable injury from driving rains. He says that they are pasted in the mud and never gain access to the plants again. The writer has frequently noticed the beneficial effects of driving rains in reducing the infestation on apple trees. In conducting spraying experiments it seems that high pressure is a valuable factor in the control of the red-spider.

NATURE OF THE INJURY

The injury by Red-spiders is confined entirely to the foliage. They have never been known to attack the fruit of apple. The fruit suffers only indirectly through the injury of the foliage. The vitality of the tree is lessened and a premature dropping of the foliage and in some cases a premature dropping of the fruit has been noticed. This pest often works in conjunction with the leaf-hopper (*Empoa rosae* L.) when it is difficult to determine which is causing the more serious injury.

In one orchard where the leaf-hopper and scab were not serious some measurements were obtained indicating a reduction in size of the fruit. The figures are presented in thefollowing table.

MEASUREMENTS OF APPLE DIAMETERS. WINESAPS.

Treatment.	Number of fruit measured	Average diameter.[1]
4 applications, Lime Sulphur	412	2.472 inches
4 applications, Dry-mix	801	2.490 "
4 applications, Atomic Sulphur	784	2.326 "
4 applications, Dry Lime Sulphur	619	2.493 "
Check	551	2.202 "

[1]In making these measurements aphis and red-bug apples were discarded in all plats.

CONTROL

There are two avenues of approach for the control of the red-spider. The delayed dormant and the summer applications have given satisfactory control. The delayed dormant applications have only recently been tried. Various miscible-oils give a high percentage kill of the eggs. While the following table shows that miscible oils will kill a large percentage of the winter eggs, even better control could be expected had the spraying been done more thoroughly. The original experiment, however, was outlined for collar-rot and fire blight and the most of the attention in spraying was paid to the trunk and larger branches of the trees. Lime sulphur did not prove satisfactory in killing the winter eggs.

VALUE OF THE DELAYED DORMANT APPLICATION

	Egg counts.			First generation counts.		
Treatment.	Total No. of eggs	No. eggs hatched	% eggs hatched	No. leaves examined	No. Red spiders	No. Red spiders per leaf.
Soluble Sulphur	3231	2711	83.9	103	69	.66
Miscible oil[1]	3047	388	12.4	103	142	1.37
Lime Sulphur	1405	1079	76.0			
Miscible oil[1]	1619	761	47.0			
Lime Sulphur	4886	3215	65.8	285	551	1.98
Miscible oil	2871	822	28.6	280	29	.10

[1]A proprietary mixture.

The delayed dormant spray cannot be relied upon, however, to control the red-spider because the small percentage of eggs that hatch are sufficient to reinfest the tree and produce an outbreak later in the summer. It is an excellent means of starting the year with trees comparatively free from red-spider. During favorable years little or no injury will result but should the summer prove to be hot and dry no

doubt they will develop in numbers sufficient to be injurious. As the delayed dormant application is used quite universally throughout Southern Pennsylvania, the possibilities of control measures here are encouraging.

Summer Applications of Spray and Dust

Summer applications of various forms of sulphur sprays have proved very satisfactory in keeping this pest in control. The sprays must be continued throughout the summer. The complete spray schedule for apple is usually sufficient to keep the red-spider in check. Sulphur and lime dusts, on the other hand, have given little or no control. As a matter of fact the most serious outbreaks of red-spiders have been found in neglected orchards or in dusted orchards. This together with other reasons have led the writer to believe that the water as well as the pressure have much to do with the control of red-spider.

The writer has found it difficult to obtain figures to illustrate control work during the summer. The following tables are presented which are summaries of field notes for a period of four years indicating the nature of the control effected. In these orchards from five to six applications were made throughout the summer. The treated plats were adjacent to each other in the same orchard. The value of sulphur was tried chiefly in the liquid and the dust form. The cost of nicotine throughout the summer prohibited its use.

Control of the Red-spider (*Paratetranychus pilosus* C. & F.)

Spray Applications

Material	Nature of Control	Number of years	Number orchards
B. T. S.	good	1	1
Atom. S. ...	good	1	2
Sol. S.	good	2	1
Dry Mix. ...	fair	1	4
L. Sul.	good	4	3

Dust Applications

Material	Nature of Control	Number years	Number of orchards
Sul. lead 90–10.	little or no.	4	3
Sulphur	some on hot days	1	2
Sul. lime 50–50.	little or no.	1	1
Sul. lead Nic. 90–10, 2%	little or no.	2	2
Lime	some when used heavy	1	1

Mr. T. J. Headlee: Did you say you used lime sulphur only in killing the eggs?

Mr. S. W. Frost: We used lime sulphur for killing the eggs but applied the regular schedule for aphis and for red spider.

MR. H. A. GOSSARD: Do I understand that nicotine was used and dry lime sulphur also?

MR. S. W. FROST: During the summer applications nicotine was not used. It was used in the delayed dormant spray.

PRESIDENT A. G. RUGGLES: Mr. William Moore will now present a paper.

CALCIUM CYANIDE

By WILLIAM MOORE, *American Cyanamid Company, New York City*

ABSTRACT

A discussion of the methods of manufacture, chemical composition and the reactions which make this compound a promising insecticide.

During the past season many entomologists have been experimenting with calcium cyanide as an insecticide. Promising results have been obtained using calcium cyanide as a contact dust or rather as an open air fumigant. Several insects for which there is no other satisfactory method of control have been successfully combatted with this material. In the form of dust, granular material or flakes it has been tested for the destruction of rodents, the leaf cutting ants of South America, various insects normally treated with contact dusts or liquids, fleas, chinch bugs, subterranean insects, crayfish and nematodes. Altogether considerable interest has been shown in calcium cyanide hence, a brief paper on what it is, how it is made and its reactions should prove of interest.

MANUFACTURE AND CHEMICAL COMPOSITION OF CALCIUM CYANIDE

A better understanding of the material may be obtained by briefly sketching its manufacture so as to obtain its relationship to other well known materials. Calcium carbide is made from lime stone and coke. Air is liquefied and the nitrogen boiled off leaving the oxygen. The nitrogen is then absorbed in white hot powdered calcium carbide forming cyanamid, $Ca\ CN^2$. The next step in the process is the fusion of the calcium cyanamid with sodium chloride in an electric furance heated to a high temperature, when the cyanamid is converted to cyanide.

The finished product is in the form of thin flakes about a millimeter in thickness. The color is black due to a small amount of carbon in the form of graphite. The cyanogen content is equivalent to about 48%–50% sodium cyanide. The product is a crude cyanide consisting of calcium, sodium, cyanogen, and chloride. It is generally considered as having the cyanogen combined with the calcium in the form of calcium cyanide while the sodium and chloride are combined as sodium chloride. Due to its method of manufacture there are traces of calcium

carbide, calcium cyanamid, and a small amount of sulphur in the form of a sulphide.

Reactions of Calcium Cyanide

The value of calcium cyanide as an insecticide is due to its reaction with water vapor to produce hydrocyanic acid and calcium hydroxide. Some entomologists have considered that this reaction is true for all cases where water is brought in contact with calcium cyanide but such is not the case. If calcium cyanide is mixed with water it forms a solution of calcium cyanide similar to a solution of sodium cyanide. A solution of calcium cyanide would appear to have no more value as an insecticide than a similar solution of sodium cyanide.

When calcium cyanide is exposed to atmospheric water vapor the reaction is similar to the reaction of moisture on calcium carbide only hydrocyanic acid is evolved instead of acetylene. The rate of this reaction is more closely associated with the absolute humidity than with the relative humidity. A temperature of 85° F with 50% relative humidity actually has a higher absolute humidity than a temperature of 65° F with 90% relative humidity. Even a low relative humidity may therefore have sufficient actual moisture present to produce a killing concentration of gas.

Sprinkling the calcium cyanide with a very small amount of water will increase the evolution of hydrocyanic acid. If sufficient water is used to wet the material another reaction occurs in which the hydrocyanic acid decomposes under alkaline conditions, with the formation of ammonia and other little known compounds, one of which is often referred to as azulmic acid.

The Use of Calcium Cyanide as an Insecticide

When the calcium cyanide dust is blown thru the air the moisture releases the hydrocyanic acid gas.

The possibility of using a gas such as hydrocyanic acid in the open to destroy insects appears at first as absurd. Further considerations and experiments have shown it's effectiveness to be due to the fact that the concentration of the gas to which the insects are exposed is of more importance than the length of exposure. Better results are obtained when a dust is delivered from a nozzle held from 3–4 feet distant from the plant than when held close to the plant. It is not necessary to hit the insects with the dust but they should be exposed to a killing concentration of gas although this concentration may only last for a moment.

When flakes are used in chinch bug barriers, if the soil is very dry and

the absolute humidity very low, it may be necessary after one or two hours exposure to lightly sprinkle the trench with water to increase the atmospheric moisture thus raising the hydrocyanic acid concentration.

In fumigating houses or greenhouses it is sufficient to spread out the flakes or granular material on newspaper since there is usually sufficient atmospheric moisture to decompose the calcium cyanide. In some cases damp papers or a moist flower basin might be used but if too much water is used the flakes become wet and the calcium cyanide decomposes to ammonia and other compounds and the amount of hydrocyanic acid evolved will be small. If the flakes are placed in buckets or jars and water poured over them a solution of calcium cyanide will be formed which does not give off hydrocyanic acid any more rapidly than a similar solution of sodium cyanide.

Dust Mixtures Containing Calcium Cyanide

In view of the nature of calcium cyanide, it is at once apparent that if the dust is to be diluted for dusting purposes, the diluent should be dry unless the dilution is made at the time the dust is applied. Combinations with sulphur, lime, talc, or clay may be used providing the material is dry. Combinations with acid materials such as dusts containing nicotine sulphate would completely destroy the calcium cyanide. Nicotine dusts containing moisture also represent an incompatible mixture.

Summary

Calcium Cyanide is a crude cyanide which reacts with atmospheric water vapor producing hydrocyanic acid.

Calcium Cyanide in contact with a quantity of water forms a solution and does not liberate its hydrocyanic acid.

If the moisture is just sufficient to wet the material a different reaction occurs with the production of ammonia and other little known compounds.

The success of calcium cyanide dust for the control of insects depends upon exposing the insects to a high concentration of hydrocyanic acid gas for a very short time.

Calcium cyanide dust should not be mixed with other materials which contain moisture or acids.

President A. G. Ruggles: The next paper is by Albert Hartzell and F. A. Lathrop.

INSECTICIDAL PROPERTIES OF SOME SULFUR COMPOUNDS

By Albert Hartzell and F. H. Lathrop, *Geneva, N. Y.*

(Withdrawn for publication elsewhere)

President A. G. Ruggles: We will now listen to a paper by L. B. Smith.

THE JAPANESE BEETLE STATUS IN 1923

By Loren B. Smith, *Entomologist, U. S. Department of Agriculture*

Abstract

In the season of 1923 the Japanese beetle, *Popillia japonica* Newm., increased the area of its distribution from 770 square miles to approximately 2500 square miles.

Owing to the increase in area and cost of inspection of farm produce at point of origin, a zone was established to include a large portion of the territory in which locally grown produce was consumed. All produce shipped to points outside the zone was inspected at the point of origin and was then shipped direct to its destination.

During the past season growers in the heavily infested territory, who applied sprays according to directions given by the Japanese beetle laboratory, obtained excellent protection of the foliage and fruit on apples, grapes and cherries, also of the foliage of shade trees and ornamental shrubs.

Measures of control have been developed whereby the larvae may be destroyed in golf courses and lawns as well as where they occur in the soil about the roots of various plants.

In addition various parasitic enemies of the Japanese beetle are being imported in large numbers in order to supplement the various natural agencies which tend to reduce the numbers of the beetle and to serve as a check on the continued increase in concentration of the beetles in the areas which have been longest infested.

Eight years have elapsed since the Japanese beetle (*Popillia japonica* Newm.) was first found in this country. From the point of original infestation the insect has increased in numbers and spread outward in all directions until, at the close of the summer of 1923, it covers an area of more than 2500 square miles. The species has not only been spreading from the locality where it was found in 1916 but the infestation has increased in density in the territory near Riverton, N. J., where the beetles have been present for the longest time. The number of grubs found in the soil during the Autumn months offers a fairly reliable index of the degree of infestation. In 1921 the largest number of grubs of *Popillia* found in a measured square yard of soil was 311. In 1922 as many as 1031 larvæ were found in one square yard of turf on a golf course. During the season just past several diggings were made in which over 1200 larvæ were found; the highest number being 1531

grubs to one square yard. As far as is known, the insect has confined its spread to an outward movement of five to fifteen miles yearly from the original territory. No new infestations are known to occur at any considerable distance from the area covered by the main infestation.

The losses caused by the attacks of the Japanese beetle and its larvæ on economic plants were greater in the aggregate in 1923 than during any previous season. The injuries to sod in lawns, golf courses and pastures, have been increasingly severe as the grubs have become more numerous. The damage to shade trees and fruit resulting from the attacks of the beetle was, in some localities, greater than occurred in any previous season. However, in the vicinity of Riverton, N. J., where fruit and shade trees were properly sprayed, excellent protection to the foliage was obtained.

Prevention of Spread by Quarantine Measures

Since the inception of quarantine regulations against the Japanese beetle in 1919, regulations provided in Federal quarantines as well as quarantines promulgated by the States of Pennsylvania and New Jersey, have been enforced. This has included the inspection of farm produce, particularly green or sweet corn, cabbage, lettuce and grapes, as well as the inspection and certification of soil, compost, manure and general nursery, ornamental and greenhouse stock. Until the summer of 1923 all restricted produce was inspected at the point where it originated, or on the farm where grown. Owing to the large size of the infested area in 1923, the greater cost of inspection at point of origin and also to the fact that the City of Philadelphia then came within the infested area, the method of carrying out the farm products quarantine was changed from one of inspection at the farm or point of origin, to a zone system on the following general plan. Taking the Philadelphia market district as a center, a zone was established with a radius of approximately 25 miles. Fully 90 per cent of the restricted farm produce originating within the beetle infested territory and coming to the Philadelphia market is consumed within the area included in this zone. All produce originating within the infested area and consigned to the Philadelphia market was allowed unrestricted movement within this zone. It was recognized that farm produce moving from the infested area to more distant points, as for example New York, Atlantic City, Allentown and Wilkes-Barre should be inspected, but since this could not be done in the market, it was inspected and certified at point of origin and shipped direct to its destination. By provisions of the State

and Federal quarantines the movement of restricted produce from the Philadelphia market to points outside the zone was prohibited. This system worked satisfactorily during the season of 1923. Inspectors were located on the roads leading out of the infested area both day and night; and in Pennsylvania the State Police cooperated with the inspection force for more than a month during the height of the beetle season. During the period July to September, 1923, thirty-five violators of the Pennsylvania quarantine were brought to trial, with the result that fines amounting to $1,045, were imposed and costs amounting to $224.10 were assessed, a total of $1,269.10.

Control of the Japanese Beetle

Experiments were conducted during the past year on the feeding habits and reactions of the beetle with reference to arsenicals on the leaf surface; the toxicity of arsenate of lead; the weathering of arsenicals; and arsenical substitutes. Results obtained in earlier experiments indicated that heavy applications of arsenate of lead repelled the beetles from foliage to which it was applied. In the summer of 1923, several apple orchards and numerous shade trees were sprayed with arsenate of lead (powder) at the rate of 3 pounds to 50 gallons of water; 2 pounds of flour were added as a sticker. Excellent protection was obtained to both foliage and fruit. To be most effective the spray must be applied between June 10th and 20th. Usually one spray was sufficient although when heavy rains occurred, it was necessary to repeat the application during the first two weeks in July.

Toward the end of the beetle season a method was developed whereby arsenate of lead can be coated and used as a spray. Under experimental conditions in cages this material gave between 90 per cent and 100 per cent kill. The coated material looks very promising since the beetles eat it much more readily, and it has greater sticking quality and gives less burning than the non-coated arsenate of lead. The cost of coating the lead is not over 1 to 2 cents a pound.

Chemotatic studies have been made with the beetle for the purpose of finding attractive or repellent materials which could be utilized either in the control of the beetle or in the protection of such plants as are not readily sprayed. It was found that some of the higher alcohols and phenols are distinctly attractive in certain strengths. If the odor is strong the beetles are repelled; while in lower concentrations they are strongly attracted. In one case beetles fed for 24 hours on an apple tree which had been sprayed with an attractant although the foliage

was heavily coated with lead arsenate. Efforts are being made to incorporate an attractive material in sprays in such a manner that the odor is given off slowly and for a considerable period of time.

A practical means was devised during the past season for the destruction and control of the larvæ in lawns and golf courses.[1] This consists of emulsifying 1 part of rosin-fish-oil soap, 3 parts of water and 10 parts of carbon disulfide as a stock solution. One quart of this emulsion is stirred into 50 gallons of water and the resulting mixture is applied to the infested turf at the rate of 3 pints per square foot.

Extensive studies are being conducted for the purpose of finding means of destroying the larvæ in soil surrounding the roots of living plants. Three years' experimental work has resulted in perfecting oil of wormseed and carbon disulfide dips for use in treating iris, perennial phlox, sedum, peonies, funkia, perennial grasses and similar plants. Various methods are being studied for the purpose of devising a means of destroying grubs when they occur in the soil ball surrounding the roots of coniferous nursery stock. The results thus far secured indicate that by adapting the methods and materials which are used to destroy the grubs in the roots of other types of nursery stock we will be able to obtain their control when they occur in the soil ball.

From experiments on the control of the larvæ by cultural practice it was found that between 40 and 50 per cent of the larvæ occurring in sod land can be destroyed by late fall and early spring plowing and cultivation.

Control by Means of Natural Enemies

During the past year large shipments of parasites have been received from Japan. Several thousand Tachinids (*Centeter cinerea* Ald.) were released this summer and beetles with fertile eggs of the parasite were collected in abundance near the point of releasement of the parasites. Some beetles, parasitized by this species, were found at a distance of 1-½ miles from the locality where the flies were released. In addition to the Tachinids, shipments of Dexiids (*Prosena siberita* Fabr.) and a species of Tiphia were also received from Japan and released in the vicinity of Riverton. The Dexiid deposits living larvæ on the soil. These burrow into the ground until they come in contact with the *Popillia* grub, which they parasitize and eventually destroy.

Studies have been conducted on various native insects which are predaceous or parasitic on *Popillia*, and it was found that the larvæ

[1]Bulletin of the Green Section, U. S. Golf Association, Vol. III, No. 10. Wash. D.C., Oct. 22, 1923.

of various species of Tabinidæ and Asilidæ destroy large numbers of grubs in low marshy situations. In addition, dipterous larvæ belonging to the family Therevidæ, genus *Psilocephala*, have been found to destroy a great many *Popillia* grubs; in some places the larvæ of this species were found as numerous as 30 to the square foot.

Studies have also been conducted for the past year on the various bacterial and fungus diseases of the larvæ of *Popillia* in the vicinity of Riverton. During the spring of 1923 a mortality of 10 per cent of the larvæ occurred in some localities, due to what was apparently an epidemic of a disease, caused by a species of Coccobacillus.

In addition to studies of bacteria, investigations are being conducted relative to the efficiency of various fungi in destroying *Popillia* larvæ. Under laboratory conditions certain forms, particularly certain *Isarias*, are extremely effective in killing the *Popillia* larvæ. However, under field conditions the virulence of the fungus is not so apparent.

Conclusions

In the season of 1923 the Japanese beetle increased the area of its distribution from 770 square miles to approximately 2500 square miles.

Owing to the increase in area and cost of inspection of farm produce at point of origin, a zone was established to include a large portion of the territory in which locally grown produce was consumed. All produce shipped to points outside the zone was inspected at the point of origin and was then shipped direct to its destination.

During the past season growers in the heavily infested territory, who applied sprays according to directions given by the Japanese beetle laboratory, obtained excellent protection of the foliage and fruit on apples, grapes and cherries, also of the foliage of shade trees and ornamental shrubs.

Measures of control have been developed whereby the larvæ may be destroyed in golf courses and lawns as well as where they occur in the soil about the roots of various plants.

In addition various parasitic enemies of the Japanese beetle are being imported in large numbers in order to supplement the various natural agencies which tend to reduce the numbers of the beetle and to serve as a check on the continued increase in concentration of the beetles in the areas which have been longest infested.

The session adjourned at 4:30 p. m.

[The corn borer papers and discussion are inserted here to carry out a vote of the Association. *Editor*]

Morning Session, Wednesday, January 2, 1924

The meeting convened at 10 a. m.

PRESIDENT A. G. RUGGLES: The morning session will be opened with a group of papers relative to the European Corn Borer.

RESEARCH PROJECTS AND A SYNOPSIS OF RESULTS IN EUROPEAN CORN BORER WORK

By D. J. CAFFREY, *European Corn Borer Laboratory, U. S. Bureau of Entomology, Arlington, Mass.*

ABSTRACT

Investigations of the European Corn Borer, *Pyrausta nubilalis* Hubn., have shown that as a supplement to the utilization or destruction of infested plants, a system of varietal selection, plus a proper planting schedule and the *thorough* plowing under of infested crop remnants and weeds, especially during the late autumn, are very effective cultural practices in combatting the corn borer. The tendency of the larva to migrate from their host plant, when roughly handled or imperfectly plowed under, and the ability of such larvae to hibernate successfully with only a slight amount of protection, renders it necessary to utilize, or destroy, infested material with the minimum amount of handling, and to plow under deeply and cleanly.

In areas of two generation occurrence, weeds are found infested, even under conditions of sparse infestation.

The reduction in yield of grain caused by injury to the stalk is very important, and in New England during 1923, the loss from this source ranged from 8% to 30% by weight, in fields representing average infestation.

Insecticide investigations have not yet developed any treatment that can be recommended. Winter mortality of the larvae has averaged 8.5% during the past four years. Activities of birds, especially woodpeckers, reduced the numbers of overwintering borers 72% in certain localized areas.

During 1923 there occurred a marked reduction of infestation in New England and in New York; while an appreciable increase occurred in Ohio and Michigan.

It is the purpose of this paper to present briefly a general discussion of the progress which has been made in some of the research projects of the European corn borer investigations and to indicate some of the results which have been secured to date. Certain of the projects which have been prosecuted will be reported in other papers to be given at this meeting; namely, the results of Parasite Introductions and Environmental Studies.

SELECTION OF VARIETIES OF CORN AND REGULATING THE TIME OF PLANTING

With regard to the project pertaining to the selection of varieties and regulating the time of planting, as a cultural control measure, it may be stated that field observations and experimental tests have indicated

that certain varieties of field corn and of sweet corn are less suceptible than others to *severe* injury by the corn borer.

This apparent difference in susceptibility has usually been involved with the time of planting and also with the seasonal habit or size of growth and the period of maturity. None of the varieties tested to date have shown any indication of possessing entire immunity from attack, even in the presence of a light or medium infestation, although some varieties suffered much less injury than others, particularly the large dent varieties producing large heavy stalks and large ears.

Judging from the results already secured, it is believed that continued investigations will evolve a system of varietal selection and a planting schedule that will be very effective as a cultural practice. In addition to the Federal work, cooperative projects with the agronomists to determine these points, are now being carried on with the State of Ohio, and a similar project is under contemplation with the State of Massachusetts.

The possibility of ascertaining morphological or physiological characteristics that are conducive to resistance in different varieties of corn, is a problem that it is hoped to approach in the near future.

Plowing

The effectiveness of plowing down infested cornstubble, weeds and crop refuse, as a farm practice in reducing corn borer damage, has been made the subject of extensive investigation in New England, New York and recently in Ohio.

While much remains to be learned concerning the behavior of borers thus treated, under all conditions, it has been determined in general, that in New England and New York, the *thorough* plowing under of infested material, particularly during the late Autumn, leads to the destruction of a large proportion of the larvae contained therein. Larvae which were plowed under in the early Autumn or in the Spring have migrated to the surface in large numbers and the question concerning the ultimate fate of such larvae in cleanly plowed fields, is still under investigation.

Under all conditions, however, it has been observed that the effectiveness of this measure is dependent to a large degree upon the thoroughness with which the plowing is done. Breaking down the cornstalks, cornstubble or other standing material before plowing, and disk harrowing immediately after plowing in heavy soils, has been found to greatly increase the effectiveness of the work.

Larval Migration Studies

During the progress of larval migration studies, the exact distance to which the larvae are capable of migrating has not yet been determined, but sufficient evidence has been accumulated to show that their migratory powers are very pronounced and sufficient to enable them to seek adequate shelter at a distance of several feet. Individuals which migrated from various host plants in the Autumn were found to have overwintered successfully in dry loose leaves, in fence posts, wooden buildings, telegraph poles, under the rough bark of trees and in such woody stemmed plants as blackberry, raspberry, sumac, elderberry and grape. Individuals which migrated in the Spring were also found in similar situations. In all instances the greater part of the migrating individuals were able to pupate successfully and emerge as adults.

This migratory habit of the larvae, together with their ability to survive in situations affording only a minimum amount of protection, renders it necessary to attach considerable importance to larvae which leave their host plant when such plants are roughly handled, and larvae which are able to reach the soil surface during the course of plowing under operations.

Host Plant Studies

In the investigations pertaining to the host plants of the corn borer, several interesting and important points were noted during the past season.

Along the northern edge of the infested area in New Hampshire, where the infestation is exceedingly sparse and only a small amount of corn is grown, the corn borer was found to be confined during the early season, to such early developing weeds as *Polygonum* and *Rumex*. There has been a theory advanced that much of the injury to plants other than corn, especially in New England, was due to an "overflow" from corn. While under some circumstances this effect has seemed evident, the fact that the borer has been repeatedly found in weeds, under conditions of sparse infestation, would seem to indicate the essentially omniverous character of the species. In this connection it is worthy of note that the borer was found in weeds at Brooklyn, N. Y., even in the presence of an exceedingly light infestation.

Throughout the older and more severely infested area of New England, the season of 1923 was characterized by a great reduction of infestation and injury to vegetables, flowers, field crops and weeds, a reflection of general conditions which will be discussed later.

In New York, Pennsylvania, Ohio and Michigan, occasional borers

have been found in approximately 20 species of plants other than corn. During the past season two fields of broom corn in western New York showed stalk infestations of 12.7% and 15.8% respectively.

Indirect Injury to Corn

During the progress of making examinations of corn to determine the amount of injury caused by *P. nubilalis*, it has become apparent that the actual reduction in yield through injury to the stalk and ear-stem, is usually the most important damage caused by the corn borer, in the instance of medium or heavy infestation at least.

It has been found quite difficult to accurately estimate the degree of this indirect injury, but during the summer of 1923 a special attempt was made to obtain information upon this point by protecting from infestation a block of 16 hills of Longfellow flint field corn plants which were situated in the center of a large plot of the same variety. From its location and the time of planting, it was expected that this entire plot would be subjected to severe injury. Egg clusters and migrant larvae were carefully removed at frequent intervals from the protected block of plants and additional protection from migrating larvae was secured by surrounding the protected plants with a barrier coated with sticky material. It proved to be impossible to entirely protect the plants under observation, but at harvest time these plants contained, on an average, less than one-third the number of larvae per plant than the plants in the remainder of the plot, and a comparison of the weight of the ears from the protected and unprotected plants showed an apparent reduction in weight of approximately 30% in the ears from the unprotected plants.

Computations in the field to determine the importance of indirect injury, have uniformly shown an important loss from this source, but a really saitsfactory and accurate method of computation has not yet been worked out. During the past season examinations which were made in two fields of field corn in New England, indicated losses in weight of ears of 20% and 8% respectively, due apparently to indirect injury. About 45% and 50% of the plants were infested in each field. Similar examinations in two fields of sweet corn, representing a stalk infestation of approximately 50%, indicated an apparent loss due to indirect injury of 18% of the ears, as compared to non-infested plants, and an increase of 31% in number of nubbins.

Insecticides

In an attempt to develop an insecticide that could be used to prevent

or limit serious injury to valuable crops such as seed corn, early sweet corn, flowers and vegetables, the best results were secured with nicotine dusts (F_2 and F_4) or with dusts in which nicotine was an ingredient (70 Lime, 10 Sulphur, 10 Calcium arsenate, 10 F_2). Lead arsenate and calcium arsenate combined in various proportions as a dust with sulphur and lime failed to give any encouraging results the first season. Calcium cyanide, in the preliminary experiments, seriously checked the growth and burned the young corn plants. Nitro-benzol incorporated into a dust gave encouraging indications as an ovicide and also proved toxic to the young larvae on contact. None of these substances can be recommended, however, in their present development since the maximum percentage of control secured was 83% for the ears and 88% for the stalks, while the cost of the experimental treatment varied from $5.68 to $31.80 per acre; approximately $9.00 per acre for the most successful treatment.

Winter Mortality

The investigations relative to winter mortality in New England during the past four winters have shown an average annual mortality attributable to this cause, of approximately 8.5%. This figure relates to larvae which passed the winter under natural conditions, and is exclusive of parasitism and feeding by birds. Judging from results to date, it is not believed that winter mortality is an important factor in reducing the larval population. During the winter of 1922–1923, however, the winter mortality, in experimental material placed along the northern border of the infested area in Maine and New Hampshire, varied from 22% to 45%. This may be indicative of a certain measure of climatic control during some winters in this northern area, a point which it is hoped can be determined by additional observations each year.

The winter mortality in New York and Ohio has averaged less than one per cent each year in the material under observation.

Feeding by Birds

Birds have been exerting an increasingly important influence each year since 1919 in reducing the numbers of overwintering larvae. From a series of 20 special observation stations which were maintained in New England, during the winter of 1922–1923, birds were found to have taken 72.2% of the larvae in five of the stations, less than one per cent in three of the stations and none in the remaining eleven stations. Woodpeckers, especially the Downy Woodpecker (*Dryobates pubescens*) were usually responsible for this beneficial activity, although robins,

blackbirds and grackles have been observed on various occasions, feeding upon the larvae in the spring.

Similar bird activity has also been observed in the eastern and western areas of infestation in New York State.

Status of the Infestation in all Areas

A brief statement concerning the status of the infestation in all areas where the insect is known to be present, may be of interest.

In New England the past season witnessed a very marked reduction in the intensity of infestation and injury. During a field survey of 222 fields in 22 representative towns, the stalk infestation was found to have decreased 46.4% (56.2%–30.1%) as compared to 1922, while the larval population decreased 71.3% (399.0–114.5 per 100 stalks). The principal factors contributing to this decrease were (1)—Due to the cool dry conditions, only 60% of a second generation developed; (2)—11.3% of the second generation (fertile) eggs dried up; (3)—61.4% of the second generation eggs were parasitized; (4)—The mean nocturnal temperatures during the oviposition period were below the optimum temperature requirements for normal oviposition. (by approx. 10 degrees).

In New York State the degree of infestation remained about the same, and occasioned very little commercial loss.

In Ohio and Michigan there was a marked increase in the intensity of infestation, as well as a considerable increase in size of the area infested. In a field survey, which included 133 fields of the lake counties, an average of 1.83% of the plants were infested with an average of 1.4 larvae per infested stalk (2.58 larvae per 100 stalks). While but very little commercial injury resulted in Ohio or Michigan during the past season, the rapid increase in intensity of infestation in this area since 1922 must be considered as very important.

PARASITE INTRODUCTIONS: EUROPEAN CORN BORER (*PYRAUSTA NUBILALIS* HUBN.)

By D. W. Jones, *European Corn Borer Laboratory, U. S. Bureau of Entomology, Arlington, Mass.*

Abstract

Native parasitism is practically negligible except in the case of the sporadic egg parasite, *Trichogramma minutum* Riley.

European parasites are studied at Hyeres, France, and shipped to Arlington, Mass., for liberation and breeding.

Five species of European parasites[1] have been liberated in this country to date. At least one other species[2] looks very promising and will be liberated in 1924. Very satisfactory recoveries have been made of one species (*Exeristes roborator* Fabr.

The parasitism of European corn borers by native parasites is negligible at the present time except in the case of the egg parasite *Trichogramma minutum* Riley, which fluctuates greatly from year to year. Its highest parasitism comes too late in the season to give best results, but in a year like 1923 the cold dry summer delayed the host and was very favorable for the egg parasite. Collections from 24 towns in Massachusetts all made rather late in the 2nd generation, averaged 61.4% parasitism by this species, which undoubtedly will help conditions in 1924 coming as it does in a season which has been especially unfavorable for *P. nubilalis* in New England.

European parasites are collected and studied at our European Laboratory at Hyeres, France. The most promising species are sent to our laboratory in Massachusetts. Early shipments were entirely host larvae from which parasites were reared and liberated, while later work has developed more laboratory breeding methods which have proven most efficient.

The status of the different imported species of parasites follows: *Zenillia roseanae* B. & B. a tachinid parasite of much promise attacks small host larvae and emerges just before pupation of the host. Its two generations synchronize perfectly with those of its host in France, and hibernation is as a second instar larva inside its living host. This species should have an extensive breeding campaign to furnish a suitable number for liberation. In 1920, 90 adults were liberated and in 1921, 784.

Eulimneria crassifemur, Thom. is a rather large hymenopterous parasite having two generations a year in France. It usually parasitizes small larvae while they are in feeding webs, and hibernates as a full fed larva inside a very compact cocoon. Thirty-one were liberated in 1920, 4,968 in 1921, and 733 in 1923.

Angitia (Dioctes) punctoria Roman is a very effective summer parasite in Italy. It is very similar to *Eulimneria* in appearance and habits, except that it parasitizes free crawling larvae as well as those in feeding webs. Only 10 were liberated in 1921, and 168 in 1922. We

[1]Tachinid *Zenillia roseanae* B. & B. Hymenoptera *Eulimneria crassifemur* Thom., *Angitia (Dioctes) punctoria* Roman, *Habrobracon brevicornis* Wesm., *Exeristes roborator* Fabr.

[2]*Microgaster tibialis* Nees.

are having some success in breeding this species, and hope to liberate a worthwhile number in 1924.

Habrobracon brevicornis Wesm. is a small hymenopteron upon which most of our efforts were expended in 1922. This species attacks full grown larvae, paralizes them, and deposits external eggs. Resulting larvae feed externally and produce an average of some 18 small white cocoons per host. Eight or even ten generations per year would be possible, as the life cycle is short, and varies greatly with the temperature. Hibernation is in the adult stage. In September 1921, 1210 cocoons were received, from which 715 male and 213 female adults issued. Four hundred adults were liberated later in 1921, and 1,054,000 in 1922. I consider it important to add that in 1921, liberations averaged 14% females, whereas our 1922 liberations averaged approximately 40% females.

Exeristes roborator Fabr. one of the old Pimpla group, is a large hymenopteron with a long powerful ovipositor and is able to locate and parasitize full grown larvae through corn stalks and even burdock stalks. The host is killed, and eggs and larvae are external. It has several generations a year, and hibernates as a full fed larva in a very thin tough cocoon. In October 1922, 1,061 cocoons arrived which produced about 500 adults of which number 56 were liberated, and the remainder were used in breeding experiments. In 1923, 28,935 adults were bred and liberated. Females predominated and through the use of a special emergence cage, were well mated before liberation.

Microgaster tibialis Nees., a small hymenopteron, shows up well in northern France, especially in the weed areas. It parasitizes second instar larvae and kills the host in the late fourth or early fifth instar and hibernates within very tough white cocoons. Although it has not been liberated in this country, we have solved most of its breeding problems through an importation of 100 cocoons in 1923, and expect to breed it for liberation in 1924.

These species mentioned, comprise those of importance found in France and Italy, but information received leads us to hope that other valuable additions may be had from Hungary and Japan.

No systematic collections for recovery of liberated parasites have been attempted, except in the case of *Habrobracon brevicornis* Wesm. and no recoveries of this species were made. However, *Exeristes roborator* has shown up extremely well in incidental collections with as high as 8% near colony sites, commonly 1 to 4% in a corn field ¾ mile from the

Arlington colony, and one extreme case of a recovery 5 miles distant from the nearest liberation point.

Plans for the immediate future call for a breeding campaign on *Exeristes roborator* Fabr., *Microgaster tibialis* Nees., and *Angitia punctoria* Roman and also a careful study of parasitism in the field, that is the recovery, dispersion, percentages and the many other factors upon which we should have data before we can efficiently pick out the various species which should have supplementary colonies established to more rapidly and more evenly distribute the more favorable species over the New England area, the New York area, and the large area bordering Lake Erie.

This program cannot be carried out at once. We can only give each species the most perfect chance possible to establish itself and let nature take its course. Nature makes the test and we note results. If we see good results we can then assist nature by laboratory breeding and save many years and thousands of dollars by proper distribution of parasites to act as breeding stock in various carefully selected localities. If you will pardon me, this problem seems a chance for a new type of entomologist, the Henry Ford type, where "Increase production and save dollars" is the motto to be made possible by "Simple, efficient equipment and systematic handling."

ENVIRONMENTAL STUDIES ON THE EUROPEAN CORN BORER (*PYRAUSTA NUBILALIS* HUBN.)

By K. W. Babcock, *European Corn Borer Laboratory, U. S. Bureau of Entomology Arlington, Mass.*

Abstract

Article contains summary of research in connection with the investigation of the seasonal history of the European corn borer (*Pyrausta nubilalis* Hubn.) in various localities, consisting of three main lines; first, possibility of two distinct species occupying areas of diverse seasonal history; second, possibility of a geographic race; third, the intimate study of the environment. The third section of the investigation is particularly reviewed, the writer attempting to emphasize the impracticability of predicting seasonal history on the basis of temperature correlations alone. There is also a review of the methods of studying seasonal history in relation to various types of environment as well as summaries of experiments upon the rest period, indicating the far reaching effect of moisture fluctuation during this period upon further development.

The importance of obtaining detailed informatiom upon the physiology during the critical life periods is emphasized as well as the desirability of making a careful European survey of the insect's seasonal history with a view of obtaining biologically

accurate means for appreciating the potentiality of the insect in various types of climate.

The basis for the investigation of the climatic relationships to the seasonal history of the corn borer might be said to be the necessity of obtaining information, in advance of dispersion to new localities, concerning the potentiality of the insect in its new environments. It is not possible in the time alloted for presentation of this paper, to give other than a very abstracted account of the projects which have been under way in connection with the problem. The research has followed three main lines, first; the determination of the possibility of two distinct species occupying the one and two generation areas; second; the possibility of a geographical race, or strain, and third; the intimate study of the environment both experimentally and hypothetically.

It was at first planned to formulate temperature correlations upon the data obtained from controlled temperature experiments, but it was found impractical and inaccurate to base predictions of seasonal history on the fluctuations of one factor. The conception of the development curve in relation to temperature as a true hyperbole does not hold except within certain limits. The other important climatic factors exert a distinct influence upon the physiological limits of the insect and upon the rate of development or velocity. It was found to be impracticable to compare localities by means of the corrected form of evaluated temperatures, since in a type of environment distinct from the one in which the material lived with which the controlled experiments were conducted, there would result a different reaction to the fluctuations of the climate. Until more detailed knowledge is gained concerning the physiology of the insect, the investigation will be chiefly field experiments and observations.

The experiments conducted with quantities of one and two generation material have shown that the progeny produce fertile eggs and in normal numbers, and the seasonal history in the majority of cases consists of two generations. Individuals which have been transferred from one to two generation areas, and vice versa, and reared in field cages, have persisted in practically the same seasonal history, after three years' study, as they were accustomed to in their previous environment.

Through the suggestions of Dr. Victor E. Shelford, of the University of Illinois, there was evolved from the constant temperature experiment data, an expression for the relation of temperature to development which has proved quite satisfactory for comparisons of seasonal history within a restricted area. However, it is believed that this type of tem-

perature correlation is valueless unless proper corrections are applied for the effects of humidity and light or other important factors as were originally suggested by Dr. Shelford.

Since it was impossible to conduct the detailed experiments upon the humidity effects, the study of the insect in its original home was stressed. The hythergraph method of Griffith Taylor, (reviewed in the August Number of the Geog. Rev. 1919) was used for comparing the foreign localities, from which seasonal history records could be obtained, with localities in the United States. Briefly this method consists of plotting two factors of the climate for each month of the year using normal monthly means. The foreign localities were grouped according to seasonal history and climatic features and the groups analyzed by means of interrelated examinations. From this study certain hypotheses concerning the one and two generation types of climate were obtained and these limits used in predicting possible seasonal history for localities

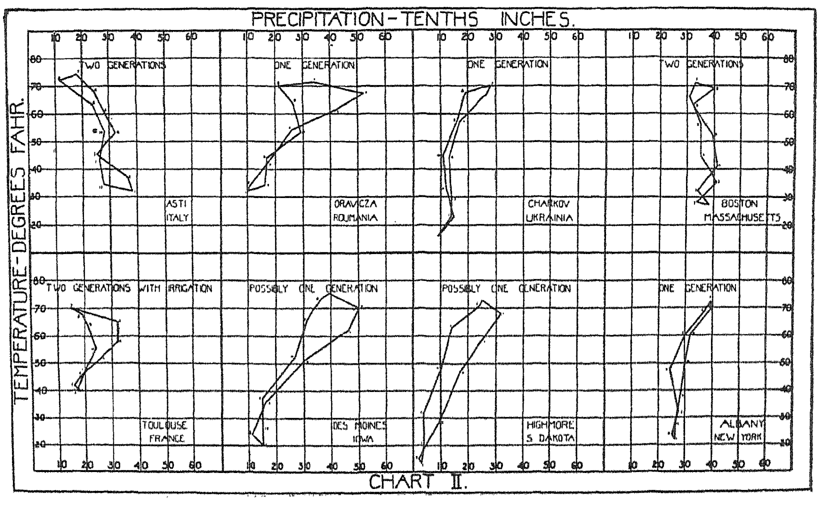

Fig. 3.—Showing type of graph used for studying seasonal history groups in the native home of the Corn Borer and for comparative work with the possibilities of adaptation in the new regions of spread.

in the United States. Chart I shows the type of graph used for comparative work as well as typical one and two generation types of climate found in the temperate zone. The bad years, i. e., seasons in which there occurred intense damage by the corn borer, were also surveyed for their climatic peculiarities, and in this manner knowledge was obtained concerning the potentiality of the insect in various types of climate.

In connection with the graphical study of the environment, experiments were carried on to check the hypotheses formulated. It soon became evident that the hibernation period of the insect was a very critical period as regards the presence of available moisture in the hibernating quarters. In fact, the hibernating larva is quite sensitive to the fluctuations of moisture of very short duration. The results of the experiments upon the hibernation period are of enough importance to warrant a brief summary.

I—Regular weekly collections of larvae, previously experiencing normal hibernating conditions were subjected to uniform incubator conditions of 80 deg. Fahr. and humidity saturation. There was exhibited during the first portion of the hibernation period, approximately the first six weeks, a distinct requirement of exposure to temperatures below the threshold of development, to assist the breaking up of hibernation. This requirement sharply decreases after this particular period, while the warmth and moisture requirements increase. It was found that the hibernating larvae are very sensitive to available moisture throughout the period, and it is essential that the moisture requirement be supplied by actual contact. High air humidity will not suffice.

As the normal time approaches for the emergence from hibernation, the larvae prefer drier hibernating quarters, but at the same time require contact with moisture obtained from the periodic drenching of the host plant by rainfall.

II—An experiment to determine what period or periods during hibernation the insect is most susceptible to moisture fluctuations. Larvae were deprived of from one to six consecutive months of normal field moisture conditions and collections made at the time of normal emergence to determine the effect of the treatment.

The results show that if any month from November to April inclusive is dry, there results increased mortality and longer time is required to emerge from hibernation than is normal. Arranged according to the highest mortality if dry, March produces the greatest delay, then April, February, January and November. As the period of dryness during hibernation is lengthened, the mortality during the spring correspondingly increases.

III—An experiment to determine what effect abnormal conditions of moisture during hibernation would have upon the seasonal history during the ensuing growing season.

(*a*) A large quantity of material kept in insectary during winter

months where it experienced practically all normal winter conditions except precipitation.

(*b*) Material placed under warm, dry conditions during hibernation, that is with a humidity of 30 to 50 percent and a mean temperature of approximately 64 degrees.

Both lots of material were placed in field cages at the time for normal pupation in the spring, and given as near natural conditions as possible. In both series the mortality was considerably above normal and the seasonal history throughout the year considerably delayed, in fact, the number of individuals completing the second generation was reduced to 38 per cent in the case of the larvae experiencing warm dry conditions during hibernation and to 75 per cent in the case of larvae experiencing insectary conditions.

The treatment was continued for the second season, and the number of individuals completing two generations during the second growing season of the experiment was approximately 9 per cent in both cases.

IV—Various combinations of drying and soaking were tried as means of breaking up hibernation during the winter months. All series of larvae were carefully weighed before and after each treatment. It was found that a definite amount of moisture was necessary for the maintenance of life during hibernation and that this moisture requirement could not be met solely by the production of metabolic water. There must be a source of moisture that can come in contact with the hibernating larva.

A combination of warm, dry conditions, followed by a return to optimum temperature and moisture will break up hibernation as quickly as an exposure to low temperature with a following treatment of optimum temperature and moisture. However, the former method results in a very high mortality if the treatment is continued for any length of time.

In general all indications seem to point to the rest period as probably the most critical period in the life of the insect, and that impresses of environment during this period may noticeably influence further development.

From the present status of the work upon the relation of environment to seasonal history, it seems advisable to investigate thoroughly the activities of the insect in its originl surroundings. The practical ends to be gained from a general European survey are as equally desirable as the scientific knowledge thus made available for an accurate foundation for further environmental comparative study. The investigation thus

far has clearly indicated several important considerations, especially the fact that until a more detailed knowledge is acquired concerning the actual workings of the physiology of the insect, definite and positive correlations cannot be made between the climate and the seasonal history when based upon the generalizations which are able to be obtained from the present type of what is termed practical experiment. Investigation of critical or easily impressed periods in the life of the insect must be more carefully analyzed, especially the determination of the physiological causes for the entrance into and emergence from the state of hibernation. The investigation of metabolic processes and the possibility of a symbiont, either yeast or protozoan assisting the physiological reactions during this period is practically an untouched field of research in connection with major problems of economic entomology.

It would seem advisable that if a dependable hypothesis is to be obtained which would set forth the details of seasonal history and possibilities of damage of the insect in particular types of environment that there either must be technical research into the physiology, or if time and money will not permit this line of endeavor, reliable information sought concerning the natural field reaction of the insect to environment in its native home.

EUROPEAN CORN BORER INVESTIGATIONS IN OHIO

By L. L. HUBER and C. R. NEISWANDER, *Agricultural Experiment Station, Wooster, Ohio*

ABSTRACT

This is a preliminary report of work done in 1923 by the Ohio Experiment Station. The life history of the insect, *Pyrausta nubilalis* Hubn., as it occurs in northeastern Ohio, is briefly summarized. There is one generation per year. Careful observations made in a definite area along the lake front showed an average infestation of more than one percent in Lake and Ashtabula counties in northeastern Ohio. The average for other lake counties is considerably less. The maximum infestation for the state is seventeen percent, found by Federal workers in a thirty acre field of dent corn near Toledo in Lucas County. No conclusive statement in regard to the efficiency of the clean up measures prosecuted in Ashtabula county in the spring of 1923 can be made at this time. A study of infested stalks showed clearly that the stubble left in the field must be seriously considered in our future control measures. Native predators and parasites are almost negligible. Three weed hosts are recorded. Although the borer has increased greatly in numbers during the past season no commercial damage has been done.

The Ohio Experiment Station began European Corn Borer Investigations in Ohio in 1923. This work was made possible thru a special

appropriation by the Ohio Legislature. Our field laboratory was located in Ashtabula County, northeastern Ohio, where the percent infestation was thought to be the highest in the state. In all our work we have been in constant touch with the State Department of Agriculture, the Ohio Extension Service, and the Federal Bureau. Particularly does the Ohio Station Staff appreciate the generous cooperation of Mr. D. J. Caffrey and Mr. F. W. Poos.

A part of our biological projects were necessarily limited because of the great difficulty in securing sufficient numbers of over-wintering larvae at the beginning of the season. Pupation began June 5 and ended August 7. The shortest pupal period was 6 days, the longest period 21 days; the average was 12 days. The season of maximum pupation was June 15 to June 20. From a small number of pupae and larvae found in the field on June 18, it is estimated that approximately 26 percent had pupated under field conditions. This corresponds closely to the percent pupated in the insectary at the same date.

Emergence of adults began June 20 and ended August 4. The period of maximum emergence was June 22 to June 28 with the peak of emergence on June 27. It should be mentioned too that an empty pupa case thought to be *Pyrausta nubilalis* Hubn. was found in a stalk on June 18 in the same field that contained larvae of the corn borer.

Female moths lived from 1 to 25 days, or an average of 14.3 days. The preoviposition period varied from 4 to 11 days, or an average of 7 days. The incubation period ran from 5 to 8 days, or an average of 6 days. The minimum number of eggs deposited by an individual was 17 and the maximum 737—an average of 235.

During the past season an attempt was made to ascertain the average percent infestation in the area that was first found infested and also to get all possible information relative to the clean up measures prosecuted in Ashtabula county last spring. Territory along the lake front and back not more than three miles was pretty thoroughly covered. The following table indicates the present infestation found in Lake and Ashtabula counties. It will be remembered that these two counties are adjacent and that Lake county had no clean up campaign.

TABLE SHOWING INFESTATION IN ASHTABULA AND LAKE COUNTIES

County	Fields exam. Sweet corn	Av. inf.	Max. inf.	Fields exam. Dent corn	Av. inf.	Max. inf.	Total av.
Ashtabula...	19	.011	.10	16	.012	.05	.0115
Lake.......	15	.014	.10	21	.013	.075	.0135

It will be noted that the difference between the average totals of the

two counties is 15 percent in favor of Ashtabula. In our opinion these data will not permit us to make any superlative claim for our efforts last spring. Similar studies of infestation were carried on in Lorain, Cuyahoga and Lucas counties. The maximum infestation in these counties was one, three and seventeen percent, respectively.

In the course of these investigations information was secured in regard to natural enemies. In only one instance has bird attack been at all noticeable. This was in a field of yellow dent which had 7½ percent infestation and which was located near a wooded area. Actual count showed about 20 percent of the borer entrances attacked. Due to the great number of crows present and to damaged ears in this field the crows were suspected of the attack.

Insect parasites were few indeed. In 410 stalks of sweet and field corn collected in northeastern Ohio and cut open between September 26 and November 15, 510 borers and 9 pupal cases of *Exorista nigripalpis* Towns were taken. This gives a 1.7 percent parasitism. These same stalks yielded an average of 1.26 borers each.

Three weed hosts were recorded, viz: smartgrass, pigweed and ragweed. Weeds artificially infested were severely attacked.

In an attempt to explain the evident increase of borer population in pite of clean up measures a careful study of stubble conditions was made. sn a one-half acre patch of Golden Bantam planted May 1 a ten percent Infestation was noted. After the corn had been harvested and the fodder fully mature ninety-three of the infested stalks were carefully examined with the startling result that 47 percent of them had borers not higher than six inches from the ground level, while a few were even below the surface level. If this fodder had been cut at the usual height for this community, nearly 300 adult larvae would have been left in the stubble in this small patch. Examination of less mature fodder revealed fewer borers in the stubble. Further data were secured in regard to infestation present in stubble of different heights in field corn. Two hundred infested stalks from corn in Lake and Lucas counties were carefully stripped of their leaves and the distance of the entrance holes from the ground was noted in each instance. Holes more than twenty-four inches from the ground were not considered. In this connection it is well to mention that twenty-four inches is about the maximum height of corn stubble in Ohio. Tabulation of data follows:

21	percent	of	infested	stalks	had	borers	in	24	inch	stubble
12.5	"	"	"	"	"	"	"	12	"	"
8.5	"	"	"	"	"	"	"	6	"	"
7	"	"	"	"	"	"	"	4	"	"
5	"	"	"	"	"	"	"	2	"	"

During the past season an experimental field with several plots of different varieties of corn planted on different dates was maintained to secure data in regard to the relative infestation of different varieties of corn as well as to obtain information concerning comparative yields of various varieties. The infestation was so slight that no definite information was gotten. However, no infestation was noted on plots planted after June 11. This work will continue next year.

Conclusions

1. There is no indication of two generations per year in Ohio.
2. The insect has increased enormously within the last year but as yet has done no commercial damage.
3. Sweet corn and dent corn are equally infested.
4. We have no evidence pointing to the probable efficiency of trap crops.
5. The longer the corn fodder stands on the stalk the greater will be the percent of borers in the stubble.
6. From 10 to 20 percent of the infested stalks have borers in the stubble.

MEASURES RECOMMENDED FOR THE CONTROL OF THE EUROPEAN CORN BORER IN THE PROVINCE OF ONTARIO

By L. Caesar, *Provincial Entomologist, Guelph, Ontario, Canada*

Abstract

In Ontario there is only one brood of *Pyrausta nubilalis* Hubn. a year; corn is practically the only host plant; most of the stalks even of corn grown on the ear are consumed by live stock; the acres of corn per farm scarcely average 10. Under these conditions control recommendations are:—Cut the corn low. Ensile it or run it through a shredder or cutting box, or feed it whole, but in last case pile uneaten portions by themselves and haul them out and burn. Leave no cut or shredded or whole corn stalks or cobs in the barn or field or elsewhere. Either burn them or plough them under. Ploughing under of stubble and corn remnants is of great value but must be thorough and they must not be dragged up later in cultivating. Prepare for thorough ploughing by first rolling or discing the stubble or by running plough shallowly beneath it and then using a harrow. Cultivate only with disc and sow with disc drill. Complete all clean up measures and ploughing by June 1st. In

severe cases plant a trap crop of flint corn ten days ahead of normal time and the main crop a week or so later than normal. Cut and feed the trap crop to cattle as soon as eggs are all laid. If infestation is severe plant dent instead of flint corn.

In order to get a true perspective of the measures recommended for the control of the European Corn Borer in Ontario it is necessary to keep in mind the following facts:—(1) That there is only one brood of the insect a year in the province; (2) That corn is practically the only host plant, though weeds growing in or close alongside the corn field must also be considered, as borers often migrate from the corn to these; (3) That in the worst infested counties—the ones for which the control recommendations are primarily intended—corn is grown chiefly for ensilage and fodder, even sweet and husking corn stalks being largely used for this purpose; (4) That the area devoted to corn in these counties scarcely averages ten acres to a hundred-acre farm.

The above conditions make control less difficult for most of Ontario than it is likely to be for many parts of the United States. There are, however, two counties, Essex and Kent, in the extreme south-western part of the province in which we shall have on a small scale much the same problem as you; for these two counties specialize in growing corn on the ear for seed and feeding purposes, devote a much larger acreage per farm to corn growing and instead of using the stalks as feed leave them for the most part in the field.

Control Recommendations for all Parts of the Province Except the Two Counties Just Mentioned

1. Cut the corn as low as the binder will cut it, or, if a hoe is used, right at the ground. This is chiefly to make ploughing under of stubble easier.

2. If there is a silo ensile all the corn, if possible, refilling if necessary. The cutting box and fermentation kill all borers in ensiled corn.

3. If there is no silo, run all the corn, if practicable, through a shredder or cutting box with the knives set close to cut it into fine pieces. Feed this to the cattle and if any remains do not leave it in the barn, since there will be some living borers in it, but throw it out into the manure and be sure this is all hauled out and ploughed under before the first of June; for soon after this the moths begin to emerge. If, however, there is no cutting box or shredder available, feed the stalks whole to the cattle but do not thrown the uneaten portions into the manure. Pile them instead by themselves and haul them out from time to time and burn

them. This is much safer than to attempt to plough them under either alone or mixed with the manure, because their large size makes it almost impossible to cover them with the plough and not to drag them up again when cultivating.

4. If any corn stalks or pieces of stalks are left unused either in the field or along fences or in the barn or anywhere else gather all these and burn them before June.

5. See that all corn on the ear is shelled and cleaned, and the screenings and cobs burned before June; also that the cobs of all ears fed to hogs are gathered and burned by the same date.

6. After the crop has been removed plough all corn fields, covering completely all stubble, weeds and debris; and later when cultivating or sowing the field do not drag these up again.

Ploughing is of great importance and control measures largely hinge on it; for, if the corn remnants are ploughed under completely and not dragged up again, parctically every borer present will perish; if, however, the ploughing is not thorough and only partly covers the stubble and debris, or, if these are dragged up again either in fall or spring, many borers will survive.

To make a thorough job of the ploughing it is often necessary, even when the corn is planted in drills, not only to cut the stubble as short as practicable but also to break it down and tear it apart by rolling and discing or some other means. Where, however, it is planted in hills the large cluster of roots to a hill makes it very difficult to cover all so thoroughly that they will not be dragged up later. Hence the hills should first be torn apart by discing and cross discing or by some such device as running a single or double furrow plough shallowlyjust beneath the stubble to cut them loose and then harrowing to pull them apart. In some soils it is probable a split log or light road leveller would do this more quickly and equally well.

The best time to plough has not been definitely determined. Apparently the farmer may choose whatever time is most convenient. He should not, however, plough when the soil is very hard and will not turn over well.

The success of the ploughing can to a large extent be spoiled by careless cultivation afterwards; for instance, last spring from half a field in which the stubble was dragged up by a toothed implement over 10,000 living borers were recovered; almost all of which would have perished had the stubble remained buried. To avoid this dragging up of stubble and debris a disc should be used instead of a toothed cultivator and a

disc drill instead of any other style. If, however, in spite of care some stubble is dragged up, it will usually not take long to pick and burn this and in a severe infestation it will pay well to do so.

In this same connection it may be mentioned that a hoed crop should never follow a corn crop; for this would mean that the stubble and debris could not be kept covered.

7. In gardens on the farm or in towns or villages all stalks of corn grown for table or other uses, also all coarse weeds among it should be pulled or dug up and burned either in fall or spring, and the gardens ploughed or spaded.

The above are the control measures which should be generally practised every year but in severely infested areas they should be supplemented by two others; namely, late planting with a trap crop and the substitution of dent for flint varieties. The trap crop should consist of about a dozen rows of some susceptible, rapid growing, average size variety such as smutnose. These rows should be planted about ten days before the average date for the district and should be in the same field as the main crop. The planting of the latter, however, should be delayed about ten days from the average date or as late as the farmer considers safe. The result in a normal season will be that the trap rows will be much taller and farther advanced than the rest by the time the majority of the moths are out and ovipositing and so will entice them to lay nearly all their eggs upon it, thus saving the main crop. Soon after the egg-laying is over, or early in August, the farmer should begin cutting the trap rows and feeding them to the cattle, thus destroying nearly all the borers in them.

The substitution of dent for flint need be made only in severely infested areas. The reason for it is that there are usually fewer borers per plant in dent and that it withstands injury better.

The above are the measures recommended for practically all the province except the two counties which specialize in growing corn on the ear. For these we have not yet had an opportunity to study carefully the best procedure, though of course much of what has been advocated for the rest of the province will apply to them. In addition it would appear that it will be necessary to break off all uncut corn at the ground either by running a heavy iron rail or planker or leveller over it on a frosty day or by some other device, and then rake the stalks into windrows and burn them, re-raking and re-burning if necessary. Following this the field, of course, will have to be ploughed. Such a procedure

will in many cases mean quite a change in cultural practices but this seems unavoidable.

In conclusion let me say that this paper has been written largely with the object of arousing discussion, so that all interested may thereby receive helpful suggestions.

PLOUGHING AS A FACTOR IN CONTROL OF THE EUROPEAN CORN BORER (*PYRAUSTA NUBILALIS* HUBNER) IN ONTARIO CANADA

By H. G. Crawford, *Entomological Branch, Dominion Department of Agriculture, Ottawa*

Abstract

Clean ploughing either in the fall or spring is the important control measure in the Canadian infestation in the disposal of that portion of the European Corn Borer population left in the field in the stubble and refuse after the removal of the crop. The larvae in the material ploughed down practically all come to the surface sooner or later with a very slight mortality. When the ploughing is done in the very early fall most of the larvae come to the surface before winter. With later ploughings an increasing proportion fail to come to the surface and remain below ground till spring. Following spring ploughings the larvae come to the surface in a similar manner and at a rate depending somewhat upon the date of ploughing. In all cases the upward movement is practically complete by June 5th. After the larvae come to the surface, which they do at night, they wander about somewhat; a small proportion enter the crop refuse if any is upon the surface and eventually come to maturity as moths, the balance, or in the absence of suitable shelter all the larvae, settle under clods of earth or in the soil and fail to produce sufficient moths to be of real importance. The larvae in the open soil simply disappear and little is known quantitatively about the various factors which cause this reduction. In a field where the refuse contained 33,800 larvae per acre, clean ploughing in spring or fall resulted in the virtual annihilation of the larval population by the time that pupation would normally be expected the following year.

Under Ontario conditions and particularly in the corn-seed growing counties of Essex and Kent, the most difficult problem in the control of the European Corn Borer is to dispose of the larvae left in the crop refuse naturally present in the field after harvest. This phase of the problem assumes particular prominence on account of the fact that the insect in Ontario is essentially single brooded and the over-wintering larval reserve in crops and plants other than corn is negligible as yet. As this condition is likely to obtain elsewhere a report on some of the results of the Canadian investigation may be of interest to other entomologists.

Some of the tentative conclusions and results of the Canadian in-

vestigations in ploughing as a factor in control have been published[5,6,7], but they differ so considerably from published general statements of United States workers, such as Vinal[1,2], Felt,[3] and Caffrey,[4] that it has seemed well to present a somewhat detailed review of the Canadian work. The results at least show in strong relief the extreme dissimilarity in the habits of the larvae in different geographic regions and the impossibility of making blanket control recommendations.

The disposal of the entire crop refuse in the field by gathering and burning was demonstrated to be prohibitive in cost as a practical farm measure even under the most favorable circumstances. Hence the effect upon the larvae and the value in control of the ordinary farm ploughing was studied intensively both by means of burial experiments with infested stalks made by hand at definite depths and by turning down ordinary crop refuse with the single furrow walking plough. As the larvae used were always in their natural position in the infested stalks the exact number of larvae present was never definitely known. An approximate idea was secured and expressed as a general minimum expectation, by counts made in stalks of a similarly injured appearance, from which the average number of larvae per stalks was determined. Nicely graduated, exactly comparable, numerical results were not secured, though the general trend and the gross results were clear.

In the burial studies the numbers of larvae recovered in the material below ground for various periods were recorded. In the ploughing experiments the larvae were taken in traps into which they crawled naturally after coming to the surface and where they were easily recovered and recorded each day.

Mortality Below Ground

Throughout the investigation mortality below ground, in important proportions, has always been conspicuously absent except in one series of experiments, in which large quantities of stubble were used in layers a foot thick and covered by 12 or more inches of soil. The only other case where significant mortality occurred was in an overwintering burial experiment in ground across which the natural drainage of the field took place throughout the fall, winter and spring.

No clear increment of death rate throughout the fall, winter or spring due to the larvae being below ground has been observed in experiments with loose bundles of ten stalks, either in burials down to 24 inches or in series of the same type of experiments at the uniform depth of 6 inches. The same was true of the larvae in material ploughed down

in the open field. During the 1922–1923 season the average death rate for all larvae studied (5149) from 19 localities and representative of the entire infested area was 6.4%, the average mortality above ground 6.5% and that for the material below ground 6.2% which was even less than that on or above the surface. It should be mentioned, however, that in ploughed land in the Port Stanley region in the poorly drained parts of the field, where the refuse was wet for long periods at low temperatures above freezing, the mortality both above (12%) and below (13.8%) the surface was relatively high and well above the average for the field. In the reasonably well drained parts of the field the mortality in the material above the ground was 4.6% and in that below ground 7%. In no real sense have these mortalities importance in practical control.

Decrease in the Number of Larvae in Material Buried Below Ground

Of the burial experiments to determine the rate of reduction of the numbers of larvae in the infested stalks below ground, the most pertinent were those in which loose bundles of from 3–10 stalks were buried at a uniform depth of 6 inches. They were in series of from 5 to 20 burials each and were taken up at intervals. The numbers of dead and living larvae in the stalks and the surrounding soil were recorded and checked against an estimated expectancy of larvae based upon the average population of the stalks used in the experiment. Such burials were made in each fall month and were in a variety of soils and situations such as sand, sand-loam both well drained and wet, clay-loam and clay both well drained and wet.

A review of the results throughout the study indicate (See Tabulation No. 1, Sect. 2, 3 and 4) that the full grown larvae gradually leave the buried material, both in the spring and fall as long as the temperature of the soil at a depth of 6 inches rises to 50 degrees Fahrenheit, for at least some part of the day.

As a result of this movement to the surface, the recovery of larvae from 6 sets of burial experiments started September 7 to 9, 1921, from which there was an expectancy of at least 300 larvae, by November 23rd totalled but 5 live larvae; practically the entire population having left the stalks. In the burials made as late in the season as October 19th there was practically no determinable active decrease throughout the balance of the season although a few larvae did move into the soil about the stalks where they were recovered. Likewise in burials made on the 11th of November no reduction of numbers of larvae was noted,

and none took place till the spring of 1922. In the spring the larvae began to come to the surface during the first week of May and by the end of May practically all the larvae had left the buried stalks. (See Tabulation No. 1, Sect. 4).

The soils in which the stalks were buried seemed to have a definite influence upon the rate at which the larvae left the stalks. The observations showed that they left most readily from wet sand-loam and with decreasing readiness from dry sand-loam, wet clay, sand, and dry clay in the order mentioned. It was also noted that where stalks were buried in single layers they were relatively very retentive of larvae. Larvae were likely to be retained for a longer time in the soil surrounding the burial in sand than in dry sand-loam which in turn retains them longer than wet sand-loam. The clays were too difficult to handle to get exact counts upon this point. In general, apart from the possible mechanical difficulty in leaving the stalks in certain soils, the rule seems to be that anything which promotes increased moisture in the buried stalks tends to hasten the departure of the larvae from materials below ground.

Tabulation No. 1 will give some idea of the progressive reduction of larvae in the material underground at various time intervals after burial in representative experiments throughout this type of study.

Effect of Ploughing Upon the Larval Population

The studies in actual ploughing included the turning under of standing sweet corn in August, the ploughing down of normal, infested crop refuse in September 1921, a series of ploughings at weekly intervals begun in late September, 1922 (reported upon in a previous study), and finally a series of ploughings at weekly intervals in the spring of 1923.

In studying the effect of the ploughing upon the larval population, the recovery of the larvae at the surface above the ground was stressed and by this daily record the exact rate at which the larvae left the buried stalks and stubble and came to the surface under ordinary agricultural practice was determined. These records were secured by establishing an 8 foot two way recovery trap upon each piece of ground immediately after ploughing and keeping it in position throughout the season. In the case of the fall ploughings the traps were taken up in the fall, the surface of the land was not disturbed in the spring and the traps were put down again on April 27th of the following year. At the end of each experimental season the stalks below the soil within the trap were measured and the stubble and larvae counted and com-

TABULATION NO. 1—TABULATION OF REPRESENTATIVE RECOVERIES OF LARVAE FROM BURIAL EXPERIMENTS AND ONE PLOUGHING WITH INFESTED STALKS AT A DEPTH OF SIX INCHES PUT DOWN IN SERIES AND OPENED AT INTERVALS. (SHOWING PROGRESSIVE REDUCTION OF LARVAE IN MATERIAL UNDERGROUND. AVERAGE MINIMAL EXPECTATION PER STALK 5 LARVAE.)

	Type of Soil	Date of Burial	Dates of examination 1921																								1922					
			August			September					October						November								April			May		
			7	18	23	5	9	19	27	28	11	12	19	24	29	31	1	5	7	11	12	14	16	21	10	18	27	9	26	27
Sect. 1.	Sweet corn ploughed down. Three hills dug in study. Expectation 171 larvae.																															
	Sand soil	Aug. 7	■	29[1]	34	3					4			2			0										0			
Sect. 2.	10 infested stalks buried in loose bundle 6″ deep. Expectation 50 larvae.																															
	Sand soil	Sept. 9					■	20	14			6		8		7			10			7		2		1				
	Wet Clay	Sept. 9					■	30		15				1					1					0						
Sect. 3.	3 infested stalks buried in loose bundle 6″ deep. Expectation 15 larvae.																															
	Sand soil	Oct. 19											■		18			21			20			29		23				
Sect. 4.	5 infested stalks buried in loose bundle 6″ deep. Expectation 25 larvae.																															
	Sand soil	Nov. 11																		■				34	37			15	1	0

[1]But two hills examined first time. Expectation 114.

pared with the average for the field. The number of larvae were checked against the number recovered on the inside of the trap to determine the percentage of larvae coming to the surface both in spring and fall.

The results of these experiments were uniform almost to the point of monotony and bore out to a remarkable degree the results foreshadowed by the hand burials, that is, the larvae left the stalks and stubble underground and came to the surface.

Tabulations Nos. 1 and 2 give representative results of these experiments, illustrating some of the points of interest. The results in tabulation No. 2 are given in seven day totals of daily recoveries by weeks after the experiments began.

The first ploughing of the season was on August 7th, 1921. It consisted of a strip of standing sweet corn ploughed under, of which one half was rolled and carried little refuse on the surface. Eleven days after ploughing 2 hills were taken up and but 29 larvae were recovered where 114 were expected (See Tabulation No. 1, Section 1). By the 23rd of September, 3 hills yielded but 3 larvae where at least 171 were expected and by November 1st no larvae were to be secured below ground and none were found the following spring. Some of the larvae which thus came up found their way into the slight refuse on the surface, ten feet of which yielded as many as 45 larvae and two corn husks 11 larvae. The rest of the larvae simply disappeared.

The early fall experiment involved normal corn refuse in a very severely infested field with an estimated population in the refuse of 31,000 larvae per acre. The greater part of this field was ploughed September 19–23, and immediately seeded to wheat. Counts in the material ploughed down showed that the population below ground dropped to .05 larvae per stubble and .2 larvae per foot of stalks, while the refuse on the surface rose in larval content to 1.75 larvae per stubble and 3.5 per foot of stalk. Only a small proportion of the larvae actually found their way into the refuse as the surface was remarkably clean. The greater proportion of the larvae simply disappeared and could not be demonstrated either in the soil, the corn refuse in the unploughed part of the field or in the grass on the headland.

Seven serial fall ploughings were carried out in 1922 (See Tabulation 2, Section 1) and were in normal refuse with an estimated larval population of 33,800 larvae per acre. The experiments began on September 28, 1922 and ploughings continued at intervals of a week until November 9th. The larvae emerging from below ground were recovered and taken from the traps daily. They began to come to the surface the

TABULATION NO. 2—TABULATION OF REPRESENTATIVE RESULTS IN THE RECOVERY OF LARVAE IN LARGE TWO-WAY TRAPS PLACED ABOVE REFUSE PLOUGHED IN THE FALL OF 1922 AND SPRING OF 1923. PORT STANLEY, ONT.

	Date of Ploughing		Larvae recovered by weeks after ploughing								Total larvae taken	Percent larvae leaving refuse
			1	2	3	4	5	6	7	8		
	Representative ploughings in fall of 1922											
Sect. 1	Sept. 28th, 1922	Number	39.	19.	3.	3.	1.	4.	0	2.	71.	85.36
		Percent	54.9	26.76	4.22	4.22	1.4	5.63	0	2.81		
	Oct. 19th, 1922	Number	18.	17.	16.	1.	4.				56.	29.87
		Percent	32.14	30.35	28.57	1.78	7.24					
	Representative ploughings in spring of 1923											
Sect. 2	April 23rd, 1923	Number	8.	18.	21.	25.	5.	21.	2.	0	100.	All but 1 larvae
		Percent	8.00	18.00	21.00	25.00	5.00	21.00	2.00	0		
	May 14th, 1923	Number	41.	9.	13.	2.	0				65.	All but 1 larvae
		Percent	63.07	13.84	20.	3.07	0					
	Representative of land ploughed in fall but not disturbed in the spring of 1923.											
Sect. 8	(Spring recoveries) Oct. 19th, 1922	Number	5.	38.	21.	25.	3.	10.	3.	0	105.	100.00
		Percent	4.75	36.19	20.	23.8	2.84	9.51	2.84	0		

night following the ploughing and continued to be taken as long as the temperature of the soil continued to attain a temperature of about 50 F. for some part of the day, which is well after frost. As great a proportion as 8.03% of the total recoveries were secured between November 10th and November 21st. At the end of the experiment, studies were made in the material below ground and it was very clearly evident that the date of ploughing was a most important consideration. Thus the following percentages of the larval population came to the surface following the operations upon the respective dates:—September 28th, 85.36%; October 6th, 61.36%; October 12th, 67.53%; October 19th, 29.87%; October 26th, 12.5%; November 2nd, 10.00%; November 9th, 12.5%. As the cool weather was approached the rate of emergence decreased, smaller proportions of the recoveries being made in the first weeks of the experiments. Warm spells were accompanied by increased recoveries and cold spells by a falling off in numbers until late November when they ceased altogether. The cages were taken up in the fall and were replaced again upon 5 of the experiments a few days after the frost went out of the ground in the following spring. The balance of the larvae which had failed to come to the surface in the fall came up in the spring. The movement upward began on April 29th and continued throughout the spring until June 8th, the bulk of them coming up in the first three weeks of May, and by June 12th when the material below ground was examined no live larvae were found.

Five serial spring ploughings were carried on in 1923 in the unploughed parts of the same field as the fall studies of 1922. These experiments consisted of ploughing down the normal refuse at intervals of a week, beginning April 23rd and recovering the larvae when they came to the surface in the same way as from earlier ploughings. The day following the first ploughing, April 24th, the larvae began to come to the surface and continued to come up until June 7th. Where the ploughing was done later in the season the larvae came to the surface much more promptly than in the earlier experiments, associated doubtless with the higher temperatures of the soil. By the 12th of June practically every larva had left the buried material but 4 larvae being recovered below ground in the five spring ploughing experiments. From the combined fall and spring ploughings (9) examined on June 12th with a calculated expectation of 427 larvae but 4 were secured below ground and 330 larvae had come to the surface and were recovered upon the inside of the traps. This practically amounts to a complete elimination of the larvae

from the material below ground by early June irrespective of the time or season of ploughing.

Of the larvae which come to the surface of the ground a small proportion enter the crop refuse still on the surface, an undiscoverable few probably migrate from the field, but what actually becomes of the great proportion of them is in large measure unknown. Studies at the end of the spring season in 1923 when the material below ground was examined show that larvae are not present in any numbers in the deeper levels of the soil, and a sifting of 900 square feet of the surface soil in representative situations to a depth of 2 inches recovered but two larvae. Examination of the grass in the headlands yielded no larvae, and cages set to recover emerging adults on the soil itself, on the headlands, and in the standing oat crop on that part of the field not used in the experiments failed to yield a single adult. Hence it is assumed that in some way as yet practically unknown, the larval population on the surface of a field is virtually wiped out.

Experiments designed to determine the possibility of moths emerging from the material below ground were carried on. In these it was noted that unless the larvae were about to pupate when buried they came to the surface with great promptitude from depths up to 12 inches. Where the larvae were in the pre-pupal stage many of them pupated and produced moths as did buried pupae. In one experiment three of these adults did make their way to the surface from burials of pupae at depths of 1 and 2 inches in a study involving 110 pupae in their natural tunnels in pieces of stalk at depths of from 1–12 inches. As a rule, however, the moths could but rarely escape from the stalks into the soil and died in the tunnels into which they had emerged. In some cases they did manage to get out short distances into the soil but died just outside the stalks. From work carried on in 1923 by Mr. G. J Spencer and Mr. G. Wishart of the Ontario Department of Agriculture it was determined that by suitable caging it was possible for larvae where deprived of more suitable shelter, to pupate and produce moths in bare sandy soil if placed under these conditions just previous to pupation. These studies also showed that a few moths were liable to mature from high concentration of larvae coming from material below ground. In this experiment a burial of 2,000 larvae per 100 sq. feet was made in the early spring and clumps of spring grains and piles of stones were arranged upon and about the burial and later caged. Fifteen adults in all were secured in 20 cages, 10 of these moths were from a two foot square plot of oats planted on top of the burial itself. Thus there is always the danger of

some quantity of the larvae producing moths upon the old corn land occupied by a crop. However, under general field conditions, as was the case in the field under study where as high as 33,800 per acre were present in the spring, practically no larvae were present in the soil to produce moths and there is apparently little danger under field condition where clean ploughing is practised of sufficient moths emerging from the field to maintain an infestation of any importance in Southwestern Ontario.

The factors which brought about the reduction in numbers of the larvae and their relative importance have not as yet been adequately evaluated and careful investigation of this part of the problem is in progress. It is doubtless associated with the prolonged exposure, particularly in the spring, to the attacks of ants (*Lasius niger* var. *americana*) beetles and birds, together with the dryness and high temperatures of the surface soil.

Based upon the findings arising out of these investigations we are unhesitatingly recommending in Ontario the clean ploughing of the corn stubble as the most practical and effective method as yet known for the disposal of that part of the corn borer population which is left in the field after harvesting and this practice with the destruction of the corn refuse about the barn yard and feeding paddocks, is considered the most important operation for the control of this pest.

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THE EUROPEAN CORN BORER, CLEAN-UP METHODS

By T. H. Parks, *Ohio State University*

Abstract

Conditions under which corn is grown in northern Ohio make clean-up work for European corn borer, *Pyrausta nubilalis* Hubn., difficult to carry out. In much of the infested area the corn is cut by hand and much of the stalk is left in the stubble. Machine cutting is being advocated to remove from the field more of the stalks,

which later should be shredded or otherwise disposed of in a way that will kill the overwintering larvae.

A county-wide effort was directed towards cleaning up and burning surplus corn stalks and suspected sweet corn stubble in Ashtabula County, Ohio, during the spring of 1923. A "corn borer burning week" was announced and carried out April 23–28. Through this organized effort of the corn growers there was secured approximately eighty percent destruction of stalk remnants which are normally allowed to remain. A study of results showed a considerable increase of corn borer infestation to have occurred in Ashtabula County during the summer of 1923, but that the intensity of this infestation was so reduced as to remove the county from first place in the number of insects found per unit of area examined.

Indications are that stubble infestation and migration from outside areas make the burning of such surplus stalks as is practicable only a partial control and not sufficient in itself to avoid rapid increase of the pest.

Clean-up measures, to check the increase and spread of the European corn borer in Ohio, must soon be installed and maintained in the infested counties. Every state in the corn belt will be vitally interested in how effectively this work is done. Thus far, with the exception of one county (Ashtabula), we have limited our efforts largely to educational work within the infested area. This has for its purpose to bring about the proper understanding of the insect and its ability to damage the corn crop.

It has been done through the following methods:

I. Taking county agents, state and county farm bureau and grange officers, press correspondents and extension representatives to Canada to see the infestation.

II. Use of moving picture showing the life history and damage from the European corn borer in institutes and community meetings within the infested townships.

III. Use of exhibits at county fairs and farm bureau offices.

IV. Newspaper articles in the local press and state agricultural papers.

The coöperation of the U. S. Department of Agriculture and State Department of Agriculture in all of these methods has been enjoyed and has contributed to the success of the educational work. As a result of these methods, we expect to have belief in the corn borer program prevail generally over the infested townships and to have the stage ready for action when campaigns for control are determined upon.

Control Policies Applicable to Ohio

The control policies recommended as advisable for Ohio were made up after carefully studying the work in Canada and Massachusetts, and

through helpful suggestions made by the Canadian and the U. S. Department of Agriculture entomologists. These methods are chosen with special reference to the practicability of their application in Ohio and are passed upon by all of the entomologists working in Ohio. They were then offered to the county agents in the affected area and approved by them. They are as follows:

1. Use of the silo for taking care of as much of the crop as possible.

2. Cutting the corn close to the ground, preferably with a binder. In the case of sweet corn, using a short type of hand cutter to cut the stalk close to the ground.

3. Shredding the corn stalks to be fed. This kills the borers.

4. Feeding sweet corn fodder green as soon as ears are marketed.

5. Plowing (preferably late fall) of stubble where corn is to be followed by oats or other spring crop.

6. Burning surplus corn stalks, about the last week in April to destroy the borers before the summer brood of moths appears.

The correct understanding of how these remedies may function, can only be had after we have analyzed the present method of handling the corn crop in northern Ohio.

Ohio Farm Methods

The infested area may be divided into two parts with five counties in each part. In northeastern Ohio, the five counties which are now infested have fairly well developed dairy interests. Practically no beef cattle are fed, silos are present on many farms, and approximately one acre out of every three planted to corn, is planted for silage purposes. This is usually harvested with a corn binder, only a small proportion of the crop being cut by hand. Since one third of the acreage is put into the silo, fall plowing would be applicable on this silage land, but for other reasons is rarely done. In all of this area the corn is cut fairly low except where it is done by hand.

The five northwestern Ohio counties which are now infested, have relatively few dairy farms. The most of this corn is grown for feeding to beef cattle or hogs. Silos are present on a small percentage of the farms. For every acre of silage corn planted, there are seventeen acres which are cut for grain and husked on the stalk or in the shock. By far the largest part of this corn is cut and shocked on the ground, the cutting being done by hand, using the straight knife type of cutter, the stubs being left from eight to twenty-four inches long. We have seen many fields in this area where perhaps one fourth of all the corn stalks

would be left in the stubble. This stubble is allowed to stand undisturbed until spring, when it is disked and oats seeded in the ground. The shocks of fodder are fed in the barn, lots or open fields during the winter. Shocks remain upon these fields until May first, oats seeding often proceeding around the shocks which still remain upon the ground. Very few farmers plow this stubble and Experiment Station records in Ohio show as good oat yields secured for disking as for spring plowing in preparing most types of soil.

We have here pictured the conditions in the two divisions of the corn borer infested counties; dairy interests on the east with most of the corn cut by machines, and grain corn growing on the west with most of it cut by hand. We are now ready to analyze the control methods. We see at a glance that northwestern Ohio counties contain as a group the most difficult conditions for effective control. With from one fifth to one fourth of the stalk left standing in the field as stubble, and the rest fed in such a way that the corn borer is not destroyed, we have conditions which must shortly be remedied if we expect efforts at suppression to be at all effective. Moreover, these counties are nearest to the great corn belt to the west, in which direction we find conditions even more favorable for the development of the insect. Indiana and Illinois farmers husk much of their corn on the stalk, which is allowed to remain in the field all winter.

Changed Practice Desirable

Ohio Extension forces are now urging the use of the silo wherever beef cattle are fed and its more general use in northwestern Ohio is anticipated.

We are now asking the growers of those counties to practice cutting close to the ground, and this is possible through the use of the corn binder. We are pointing out to them that the use of the corn binder is now more economical than cutting by hand. We are attempting especially to encourage the more general use of corn binders in northwestern counties, though in the face of the present price deflation of farm products and high prices of farm machinery, the adoption of machine cutting will be difficult.

Fall plowing has not been urged because of the impracticability of this method except on silage ground. Moreover, we are not sufficiently convinced of the time of year when plowing is most effective. The presence of shocks on the ground serves to prevent this being done in northwestern Ohio and where corn is cut for silage, there is less need for the fall plowing due to the short stubble.

Spring clean-up by burning infested stalks, appears to be the most

effective weapon. This method was used in the spring of 1923, an intense clean-up campaign being put on in Ashtabula County, northeastern Ohio.

Clean-up in Ashtabula County

In the summer of 1922, federal scouts reported Ashtabula County to have the most corn borer of any Ohio county. The highest infestation at that time was approximately one percent of the stalks infested in a few fields near the lake shore. However, no farmers had observed corn borers unless it was brought to their attention. The entomologists in Ohio felt that Ashtabula County alone, perhaps had enough corn borers to make the start in clean-up desirable. This took the form of a burning campaign, plans for which were made and carried out by the farmers themselves under the direction of the entomologists. The county farm bureau was the main organization used, and the county agent the leader of the project. The cooperation of the U. S. Department of Agriculture in conducting the campaign, and of the State Experiment Station in follow-up work during 1923, made it possible to cover the area effectively and to measure the results of the entire campaign. It was hoped that a thorough test of this method in this county would point conclusively to the value of burning in a subsequent campaign in 1924 over the entire area.

The week of April 16th to 21st was set apart as publicity week, during which the Extension Entomologist and county agent appeared in the schools and at township meetings over the infested area in the county. Talks were given before 3620 people, and in this way homes were reached through school children which, as later found, proved to be an ideal method of impressing the parents.

Newspaper articles were prepared and given to the papers to be released each day of the week. Each article pointed out one particular phase of the corn borer problem and how it depends upon spring burning for its solution. The cooperation of editors was secured in all towns. The drive was given publicity through editorials, and in one case, in large type across the bottom of the front page.

Cartoons showing the need of spring burning, were prepared on lantern slides and these furnished to picture show houses within the area. This, together with the newspaper items and school visits, brought the matter to the attention of town residents who were asked to properly dispose of crop remnants in back yard gardens.

Exhibits showing pictures of the devastation in Canada and Massa-

chusetts, were on display in three of the main towns. During the week of April 23rd to April 28th, the burning campaign was made. During this week five federal men with their own cars, each covered a district of the county for the purpose of visiting individual farms where need for clean-up was evident. They covered a certain territory each day and carried printed instructions to leave with the farmer. This informed him of the purpose of their visit and what it was desired to have done, making their work effective even when the farmer himself was not found at home. At the end of the week, these men reported that with few exceptions, the farmers had entered into the work with determination, and that perhaps eighty percent of all crop remnants, which could be burned, had been consumed by fire.

The Outcome

Early in May the State Corn Borer Investigational Laboratory was established at Geneva, Ohio, and the men at this laboratory made an earnest effort to determine the outcome of the burning project and what it meant in reducing the infestation if any, over what it was in areas not covered by this campaign. They examined numerous fields for infestation in Ashtabula County and compared them with the infestation found in Lake County, Ohio, which is the adjoining county west, where no burning had been done. In 1922 Lake County stood second only to Ashtabula County in intensity of stalk infestation. The result of the 1923 examinations showed that the burning campaign had without question been effective in reducing the infestation under its normal increase. It had not been effective in preventing a strong increase. Instead of Ashtabula County being the heaviest infested county at present, Lake County now bears that distinction, it having about 1.5% as much stalk infestation as Ashtabula now has. This appears to be due to the burning campaign.

In searching for a reason why the burning was not more effective, we are forced to conclude that though 80% of the stalks were burned, probably 40% of the crop of borers escaped in the stubble, and stalks handled in such a way that burning was not practical. It is also important to remember that if the corn borer is capable of migrating across Lake Erie, any burning campaign on a scale as small as county-wide, will be rendered less effective because of unburned areas to the east and west. Migration of the moths from these areas would have its effect.

The above results, which may be classified as satisfactory but not effective in themselves, were obtained in a county where corn is cut

rather low and one-third of it goes into the silo. If we were unable to seriously check the development of the pest under these conditions, it is bound to be much less satisfactory in counties farther west where only one acre in seventeen goes into the silo and where much of the corn is cut by hand, the stubs being high.

We must infer from this test that burning is desirable, but to be most effective must be supplemented by other methods more difficult to incorporate into practice. These would include more general use of corn binders and handling of the crop in such a way that the surplus could be burned. The 1924 program includes burning for all infested townships in the ten counties. We do not expect to stop the progress of the borer but if its normal multiplication can be reduced thereby to the extent of retarding its increase and spread we feel that our efforts will be well repaid.

CORN BORER LEGISLATION IN CANADA

By L. S. McLaine, *Entomological Branch, Ottawa, Canada*

Abstract

European Corn Borer legislation in Canada is divided into two main groups, foreign and domestic quarantines. In 1919 an embargo was placed on the infested areas in Massachusetts and New York, which prohibited the importation of products likely to harbor the pest. This regulation has been amended each year and practically compares with quarantine 43 of the United States Department of Agriculture.

Broom corn from countries other than the United States may not enter Canada, unless it is accompanied by a certificate of inspection and sterilization, issued and signed by an officer of the United States Department of Agriculture, as no facilities are available for the treatment of infested shipments at Canadian seaports.

With the discovery of this insect in Ontario in 1920, a qurantine was placed on the infested areas prohibiting the removal of corn. This quarantine has been amended each year to include the newly infested districts. In December 1923, 162 townships, covering 12,616 square miles, were under quarantine. Eight townships found infested in 1923 will shortly be added to the quarantined area.

The enforcement of the quarantine consists of issuing press notices; distribution of quarantine maps to post offices, banks, transportation companies, produce dealers, etc.; placing of warning signs at road intersections leading out of the area and road side banners on highways, etc.

Inspectors are stationed at larger shipping centres, on main automobile highways and attend fall fairs and exhibitions etc.

The history of European Corn Borer legislation in Canada is divided into two main groups, foreign and domestic quarantines. When it was realized that this insect was a serious menace to agriculture in general, and upon its discovery in Central New York early in 1919, steps were

taken to prevent the importation of infested products into Canada from the infested areas in Massachusetts and New York. The first quarantine affected corn only and was passed on May 19th, 1919. Since that date new embargoes have been issued each year which included the new areas found infested and also conformed more or less to quarantine 43 of the United States Department of Agriculture.

In an endeavour to prevent the further importation of the European Corn Borer on shipments of Broom Corn from Europe, etc., instructions were issued to all Canadian Corn Broom manufacturers to the effect that all importations of broom corn from countries other than the United States must be accompanied by a certificate of inspection and sterilization if that was considered necessary, issued and signed by an officer of the United States Department of Agriculture. It was necessary to take this action in view of the fact that there were no facilities for the sterilization of broom corn at Canadian seaports.

The European Corn Borer was found in Welland County, Ontario, in August 1920, a few weeks later Elgin and Middlesex Counties were found infested. During the early fall of that year the inspectors stationed at the London, Ont., fair found that it was the usual practice for livestock men to feed corn fodder to their cattle, etc. and many of them brought corn from their own farms. Some of this fodder was found infested and in order to prevent its removal to uninfected areas, a ministerial order was placed on the city of London which prohibited the removal of corn from the city limits.

In the following November, Quarantine, No. 1 Domestic was made effective. This prohibited the removal of corn from infested townships. This quarantine has been amended from time to time in accordance with the spread of the insect. In February, 1922, a double quarantine was placed on the more heavily infested areas, namely Elgin and Middlesex counties, which prevented the removal of corn to the more lightly infested districts.

At the present time (December, 1923) one hundred and sixty-two townships covering 12,616 square miles are under quarantine. Eight additional townships were found lightly infested during the past scouting season and will be added to the quarantined area at a later date.

The publicity methods followed in connection with the domestic quarantine consisted of the issuing of press notices at frequent intervals; the distribution of coloured maps, showing the area quarantined, to all post offices, banks, railroad stations, express offices, steamship companies, wholesale produce dealers, agricultural societies, and associa-

tions and officials in southern Ontario; the placing of cloth warning signs at all road intersections leading out of the quarantined area; and the use of large roadside banners on the main automobile highways.

The co-operation of the steamship and railroad companies was sought in connection with the source of supply of table corn for the lake boats and dining car services, and arrangements were made whereby all corn used for these services was purchased outside the area actually infested by the European Corn Borer. Inspectors were stationed at the larger shipping centres, such as Windsor, Sarnia, Hamilton, Toronto, etc. to watch the shipments of corn forwarded by express or boat. It must be stated in this regard that the transportation companies co-operated in this work to the fullest extent possible and endeavored to ascertain the nature of all shipments previous to accepting the same. In one instance corn was found in a package labelled fresh meat.

During the sweet corn season inspectors were stationed on the main automobile highways, on Saturdays, Sundays and holidays. No infested corn was seized on the highways leading out of the lightly infested area, but seventeen infested ears were seized on the highways leading from the double quarantined area.

In addition to the foregoing a watch is maintained in the shipping of live stock, particularly hogs, as corn on the cob is frequently fed to these animals en route. It has also been necessary to keep in touch with the contractors who handle the manure from the stock yards at a point like Toronto, as it has been found that manure is sometimes shipped in car load lots for some distance, to market gardeners, fruit growers, etc.

Inspectors are also stationed at fall fairs and winter exhibitions to see that the quarantine is maintained. In accordance with the quarantine, provision is made for exhibits of seed corn on the cob to be sent to fall fairs, etc., for exhibition purposes only, these are inspected on arrival at the fair and if they originated in the quarantined area, must be returned to that area at the close of the fair.

OPERATION OF QUARANTINE NO. 43 ON ACCOUNT OF THE EUROPEAN CORN BORER

By L. H. WORTHLEY, *European Corn Borer Work, Arlington, Mass.*

ABSTRACT

Quarantine No. 43, on account of the European corn borer, *Pyrausta nubilalis*, in New England, includes corn, broom corn, celery, green beans in the pod, beets with tops, spinach, rhubarb, oat and rye straw, cut flowers and plants of chrysanthemum, aster, cosmos, zinnia, hollyhock, gladiolus and dahlia.

In New England the quarantine on vegetables, with the exception of corn, is lifted from January first to May thirty-first of each year.

The quarantine work in New England is conducted mostly thru the Boston wholesale vegetable and flower markets, although there are some large growers in the quarantined area where inspection must be made at their shipping houses prior to movement outside the quarantined area.

In New York, Pennsylvania, Ohio and Michigan, the quarantine extends only to corn, broom corn (including all parts of the stalk), Sudan grass and all sorghums, and is operative the entire year.

Road inspection work is now conducted only in the State of Ohio, on main roads running south and west. Inspection is conducted 24 hours a day on eighteen of these roads, from June 15th to September 15th, inclusive.

Close touch is kept with seed corn dealers relative to the shipping of seed corn on the cob, which is not permissable in any section under quarantine.

The first Federal quarantine declared against the European corn borer was No. 36, effective October 1, 1918. This included only corn products within the infested area, which at that time was confined entirely within the State of Massachusetts.

Scouting of the adjacent territory during the season of 1919 developed considerable spread and it became apparent that the European corn borer had infested many new towns in Massacusetts and extended its range to a few towns beyond the State border into New Hampshire. Several garden crops were found to be badly infested and it was evident that grave danger of spread would result from the transportation of these products.

On March 29, 1920, Quarantine No. 43 became effective; this included corn and broom corn, celery, green beans in the pod, beets with tops, spinach, rhubarb, oat and rye straw as such or when used as packing, cut flowers or entire plants of chrysanthemum, aster, cosmos, zinnia, hollyhock, and cut flowers or entire plants of gladiolus and dahlia, excepting bulbs thereof, without stems.

During the season of 1919, infestations of the European corn borer were discovered near Albany, New York, and in the western part of New York State at Silver Creek, just south of Buffalo. A small infestation also was discovered near Girard, Pennsylvania. These new areas were included in the quarantine by amendments, effective March 29, 1920. The immediate operation of the quarantine in all infested sections consisted of the issuing of permits for shipment of products, including corn, grown outside the quarantined areas.

A large proportion of the products raised within the quarantined areas were for shipment outside the area, it therefore became necessary to institute some method of inspection. As regulations provided for

certification of entire fields, the following procedure was adopted: Where, after inspection, fields were found free from infestation, certificates were issued permitting the movement of products outside the area. This method worked very well until the middle of the summer of 1920, at which time celery in the New England area became ready for the market; it then was found that certification of fields of celery was not practicable, owing to the method used for bleaching the plants, which concealed them to such an extent that inspection could not be made. Washroom inspection of the crop, after being taken from the field, was then adopted. This rendered the operation of the quarantine there very expensive, as very large quantities of celery were grown in the Boston area. The field inspection method was continued with respect to other products during the summer of 1921, but infestation developed so generally in beets packed with stems and leaves attached, that field inspection became impracticable and consequently the washroom inspection method was adopted. This change added appreciably to the expense of quarantine operations.

In the infested areas in New York and Pennsylvania it was found practicable to certify quarantined products in the field, because there was but one generation per annum in these areas. During the summer of 1921, scouting work conducted in Ohio and Michigan resulted in finding a light infestation bordering Lake Erie in both States. During the period from the initiation of the quarantine regulations in the areas outside of New England to the fall of 1921, no borers had been found in any of the quarantined products, other than corn, and as a logical result, Quarantine No. 43 was amended November 15, 1921, to include only corn and broom corn, sudan grass and all sorghums, in the States of New York, Pennsylvania, Ohio and Michigan, thus eliminating a large amount of unnecessary inspection work.

Upon careful investigation, it was found that the native products under quarantine in New England were practically all consumed by January first of each year, and that the corn borer was not active in products other than corn and flowers until June first following. With these facts in view, Quarantine No. 43 was amended to provide for the free movement of all vegetables under quarantine, not including corn or cut flowers and plants, from January first to May thirty-first of each year.

As the infested area in New England increased in size, it became apparent that large quantities of the products certified in the field and washroom were not being shipped outside of the quarantined area. It

therefore became most desirable to reduce the heavy expenses of inspection and certification. As a result it was decided to abandon all field inspection work except where shipments were made direct, and to confine to the Boston market district the inspection and certification operations on products actually shipped outside the area. A Quarantine Station was established in the Boston market, which provided for inspection either on the Station premises or at the dealer's place of business. This method proved very satisfactory and was the means of effecting a large saving in the operation of the quarantine.

Quarantine 43 at present includes all of the vegetables and flowers named in the original act, in New England, but in New York, Pennsylvania, Ohio and Michigan areas, it extends only to corn products, as these afford practically the only means of artificial distribution.

No corn grown within the quarantined areas is certified for shipment from any infested section.

In all cases, the common carriers are notified regarding the quarantine and receive "Warning" posters, listing the towns included. The executive officials of these companies issue very explicit orders to employees that the Government regulations relative to the movement of quarantined products must be strictly adhered to.

The depots of these companies are visited by our inspectors at different intervals and shipments checked. However, but few violations have been discovered which were due to their negligence.

Another possible means of causing spreads occurs thru transportation by automobiles and auto trucks. Although "Warning" posters are distributed throughout the entire area, many people transporting quarantined products by auto truck apparently think these regulations do not affect them and that the Department has no method of checking their movements. Frequent visits are made by inspectors to cities and towns outside the quarantined areas to ascertain whether quarantined products are being shipped from the quarantined areas without certification. Some violations have been discovered in these instances. Automobilists continually attempt to carry quarantined products outside the areas without certification. This particularly applies to people going to week-end resorts, carrying their provisions with them. In the early days of the quarantine, a road watch was established in New England at the State lines of Massachusetts, New Hampshire and Maine. This inspection was conducted during one season by the Federal forces, and subsequently operated by the authorities of the various States.

Incidents of both serious and amusing character have occurred in connection with this road patrol work. Many people supposed the inspectors were prohibition agents searching for liquor and they would either turn back or throw away their evidence of guilt. Another class would drive past the inspectors, refusing to stop. In such cases notation was made of their auto registration and their names forwarded to the States for prosecution. One of the difficulties encountered in conducting this work was inadequate State authority to stop, search and seize quarantined products. We were unable to secure any cooperation of this nature from the State of Massachusetts, while on the contrary, Maine and New Hampshire readily deputized our men, giving power to stop, search and seize.

Road watch work is now conducted only in Ohio and excellent co-operation is enjoyed with the State of Ohio in this work. During the past two seasons our inspectors stopped and searched all vehicles on twenty-six roads running south and west from the infested area. On eighteen roads, inspectors were stationed continuously, day and night, and as a result a large quantity of corn was seized from automobiles. It was not possible to compile complete data on the infested ears included as we were obliged to retain the corn for a certain length of time in case the owner requested its return. However, I believe some sixty larvae were found in corn taken from automobiles, although many of the ears were not inspected. Some violations of regulations were discovered in Ohio thru this road work. In one instance, an automobile containing a man and woman were signalled but the driver refused to stop. They were pursued by our inspector and compelled to stop, when both man and woman proceeded to "beat up" the inspector. He afterwards secured a warrant for the arrest of the man, who was haled into court and fined $165.00, which he paid. In another instance in Ohio, a man was fined $1000. for violating the quarantine. This fine was remitted, but with provision that if found guilty of repeating the violation within the next five years, he shall pay the fine. An amusing sight was to observe some thrifty tourists, when warned of the quarantine, stop, cook their corn at the roadisde, eat it, then proceed on their way, which method of sterilization was, of course, entirely satisfactory.

Another important phase of the quarantine is seed corn on the cob, requiring constant watchfulness. Many large growers desire to purchase seed corn on the cob, but when they find this is not possible under quarantine regulations, they buy it elsewhere or allow it to be shelled.

The Postoffice officials have rendered excellent cooperation as many

small shipments of quarantined products are intercepted in the mails.

The principal quarantine work in New England in the future will consist mainly of inspection of shipments of cut flowers, many of which are sent long distances. The following tables will show something of the number and variety of shipments and how the infestation doubtless would have spread had not quarantine existed.

Report on Quarantine Lines in Ohio

August 15—September 15, 1922

No. of vehicles stopped	No. of ears corn taken
123,233	594 doz. or 7,128 ears

July 23—September 15, 1923

No. vehicles stopped	No. vehicles refusing to stop	No ears corn taken
938,793	3,536	4156 doz. or 49,872 ears

(All lines discontinued on September 15.)

Summary of Numbers of European Corn Borer Specimens Reported by Inspectors in the New England Quarantine Area on the Principal Plants Quarantined

	1920	1921	1922	1923	Total
Beans	264	54	383	316	1,017
Beets	369	3,511	12,867	505	17,261
Celery	1,915	3,188	766	2	5,871
Spinach	15	60	166	13	254
Rhubarb	135	214	28	30	407
Asters	31	0	4	12	47
Chrysanthemums	865	16	16	5	902
Dahlias	0	0	45	10	55
Gladioli	8	42	162	54	266
Hollyhocks	0	0	2	1	3
Totals	3,602	7,085	14,448	948	26,083

Statement of cut Flowers Certified for Shipment to Points Outside the Area quarantined on Account of the European Corn Borer

June 1—Dec. 15, 1923

	Asters	*Chrys'ms*	*Gladioli*	*Cosmos*	*Zinnia*	*Dahlias*	*Hollyhocks*		*Total*
Maine	17,007	33,532	11,963	6	96	60	114	Me.	62,778
N. Hampshire	17,215	20,565	10,376	75	12		88	N. H.	48,331
Vermont	15,944	42,506	5,289		12		12	Vt.	63,263
Massachusetts	346	14,759	15,333					Mass.	30,438
Connecticut	6,876	6,159	15,240	100	33	76	36	Ct.	28,520
Rhode Island	8,298	18,590	7,941	252	12	49	84	R. I.	35,226

California......	13					8		Cal.	21
Cuba..........			5,000					Cuba	5,000
Canada........	4,772	7,825	2,129					Can.	14,726
Delaware......	6							Del.	6
Dist. of Col.....	15	1,000	2,639			18		D. C.	3,672
Illinois.........	27		48			18		Ill.	93
Kansas.........		6						Kan.	6
Kentucky......	30	430						Ky.	460
Maryland......	72	48	228					Md.	348
Mich...........	39	102	24			2	50	Mich.	217
Minnesota.....		48						Minn.	48
Missouri.......	50	50	37					Mo.	137
New Jersey....	100	778	279			10		N. J.	1,167
New York.....	51,097	49,831	618,338		386	1,799	312	N. Y.	721,763
Pennsylvania...	6,457	270				164		Pa.	6,891
South Carolina.	24		100					S. C.	124
Virginia........	26	245						Va.	271
Wisconsin.....	24							Wis.	24
Ohio...........	203	712	12					Ohio	927
Florida.........	2							Fla.	2
England.......	6		6					Eng.	12
France.........		12						France	12
China..........			107					China	107
Total.........	128,649	197,480	695,089	433	551	2,204	696	total	1,024,102

(The units represented above are single blooms in the case of cut flowers)

Mr. W. C. O'Kane: In the limited time remaining, I have no desire to occupy more than just a moment. You may be interested in two notes. Beginning last spring, a major project was started at the New Hampshire experiment station on the European Corn Borer. The summer's work has shown that this season in New Hampshire the European Corn Borer had two generations. The other note has to do with the relation of weeds. There is an impression among many that there are more weeds to the square mile in New England than in Ohio, for example. In the lack of definite information, it would be difficult to say. One has to judge by impressions, of course. I have spent some time traveling by automobile in Ohio recently. While there is much wild land in New England, much forest and hill pasture, etc., so far in weeds are concerned I think that the proportion to the square miles a Ohio fields is much greater.

If the weed problem is important in relation to the corn borer, I'm afraid that it is going to be difficult in the central states.

MR. G. A. DEAN: It seems to me the more we study the activities and habits of the European corn borer, the more we are convinced that it is an insect of major importance, or at least the indications are that where this insect becomes establishd in the great corn belt of America it would do a large amount of damage unless farm practices different from those that are now used are put into operation. I think we are all convinced that the corn borer problem is not one of only the entomologists and agronomists located in the infested states, but is also one in which every entomologist and every agronomist in all the corn producing states should be interested. Since it is only a question of time until the corn borer reaches your state, it should behoove every entomologist of the corn producing states to cooperate with his agronomist in an effort to practice a type of agriculture that will reduce the injuries to the least possible minimum. I hope some of the entomologists of the corn states will be interested in this problem to such an extent that they will be willing to come to Ohio next spring and assist us with the clean-up campaign that we are attempting in the infestation bordering on Lake Erie. I can assure you that an invitation will be extended and a most hearty welcome given any one that can be present.

While I am speaking of the corn borer, there is one criticism or a statement that has been made by two or three concerning the corn borer work. They have noticed in some of the published papers on the investigations in Canada and the States, and also in conversation with these workers, that there is apparently some disagreement in some of the recommendations and they wonder why we do not get together in this matter. I want to state very emphatically that the Canadian workers and the workers in the United States consider the corn borer problem as a big cooperative project and in every respect there is an exceptionally fine spirit of cooperation. During the past year there have been several conferences by all the investigators in the principal infested districts. Nothing is withheld, but on the other hand, one investigator knows just what the other is endeavoring to do. The results accomplished and the future plans of investigation are discussed. In my opinion there are no more differences or statements are no more conflicting in the results secured and the recommendations made by the workers of Canada and the States than any state entomologist would find in a state-wide entomological investigation conducted in his own state. If you will take into consideration that the corn borer in Canada and in Ohio is one-brooded and infests only a few different plants, while

in Massachusetts it is two-brooded and has been taken in over one hundred plants, you can readily understand that recommendations will differ in the different localities.

Mr. S. B. Fracker: I understand that propaganda is being put out by the Commissioner of Agriculture of Massachusetts indicating that there are probably two biological strains of the European Corn Borer and that one strain having two generations occurs in Massachusetts while the one in Ohio has only a single generation.

I would like to inquire what the opinion of the entomologists who are closely associated with this insect, is in that respect and whether there is any evidence to indicate that the introduction of specimens into Ohio from the infested area near Boston would result in two generations a year.

Mr. L. O. Howard: I think Mr. Babcock answered that question as far as it can be answered, in his paper. I heard Mr. Caffrey say something about the receiving end of the parasite work. The members may be interested in knowing something concerning this work in Europe. A parasite laboratory was situated two years in the central part of France in the corn-growing region, but it was rather difficult of access to the principal seaport. Later it was moved to a section near Marseilles and is being conducted by Mr. W. R. Thompson, with a number of expert assistants.

Mr. H. W. Babcock: May I answer Mr. Fracker's question? We have no definite evidence at present that the difference in the number of generations in various localities signifies a biological strain. It seems at present to be the result of long years adaptation to general types of climate. We are contemplating, however, starting a project to investigate the influence upon the insect of a symbiotic interference so that we can determine whether or not there are persistent strains, regardless of the normal fluctuations of the climate within a restricted locality. As far as the seasonal history is concerned, the indications are that the northern part of the state cannot support more than one annual generation. Further south there is a very good chance for two generations, and in the northwestern part of the state is an area which has a type of climate permitting intense damage over several consecutive years.

Mr. R. C. Treherne: Supplementing the remarks of Prof. Dean relative to the cooperation of officials investigating the European Corn Borer in the United States and Canada: It was a matter of great surprise to me to hear there was any question on this point, for the reason

that in no problem with which I have been connected during the past ten years has a better spirit of cooperation existed.

For the information of those who are not familiar with the circumstances, frequent visits during the past few years have been made by the various officials to each other's laboratories and all connected with the problem are or should be fully conversant with all the findings. Even manuscript has been exchanged previous to publication—quite an unusual feature—and parasites have been received through the courtesy of the U. S. Bureau of Entomology and liberated on a jointly conceived plan. That differences occur in the results obtained from certain control measures is natural but no doubt should exist in any one's mind that these variations are known and fully recognized by every one connected with the problem.

Mr. H. G. Crawford: I deeply regret, with Mr. Treherne, that there should be the slightest feeling abroad that there was not the most complete cooperation between the United States and Canadian investigations. Mr. Treherne's remarks can have left no doubt upon that point and I most heartily endorse everything he has said.

However, I can see some justification for a feeling that the recommendations arising from the results of our several investigations differ markedly. This arises from the fact that the work is being carried on under vastly different conditions. The Arlington investigations are proceeding under conditions of extreme complexity, where the insect has two broods and where corn is really responsible for but a small proportion of the borers present. The Ontario conditions, on the other hand, are relatively simple. There the insect is single brooded and corn is as yet the only real host plant. Thus fall ploughing in the two zones, for example, is affecting larvae of very different ages and naturally enough with different results. This is, of course, understood by those directly engaged in the work through the exchange of information, but may very easily not be realized by others in listening to progress reports. This feeling is intensified by the incomplete nature of the studies and a failure upon the part of the investigators to sufficiently stress the peculiar conditions obtaining in the area in which the work was carried on.

The whole-hearted aim of the various investigators is to work out a practical control of the widest application possible in the shortest space of time, and to this end the very fullest reasonable exchange of information and results of work accomplished is carried on between the various investigations.

Mr. Lawson Caesar: I should like to ask Mr. Parks his reason for not

advocating plowing in Ohio. In Ontario we believe that we must not only cut the stubble low—just as low as the binder can cut it—but also plough it down and keep it under, otherwise we could not make any progress in controlling the borer. To emphasize this I may say that in stubble cut not higher than 6 inches we have found over 24,000 borers per acre. So you can see what would happen if this stubble were not ploughed under.

MR. T. H. PARKS: Perhaps I can clear up our situation in a way. We believe that if the farmers in northern Ohio burn the surface and plough, they will kill most of the larvae.

[End of corn borer discussion. *Editor*]

Scientific Notes

The Oak Girdler, Oncideres quercus Skinner. On September 28, 1923, while collecting in Oak Creek canyon near Sedona, Arizona, we found oak limbs girdled by *Oncideres quercus*. After a diligent search we discovered the beetles, one of which was in the act of depositing eggs in an already girdled shoot. One bush noted was suffering with twenty-six girdled limbs.

While building a fence, oak bushes had been cut off a few feet above the ground, causing them to put out numerous succulent shoots from the base the following season. The insects evidently preferred this sappy wood on which to feed and deposit eggs, as they selected it in preference to the normal growth. For food the adults climb to the extremity of the limbs and feed on the tender bark at the tips of the shoots, and particularly around the leaf buds. The girdled limbs are from one to three feet long and average one half inch in diameter. They have about one egg puncture to every one and one-fourth inches, but no egg is deposited in over half of these. The insect inserts the egg between the bark and the wood and by a secretion causes the bark to raise in a blister so that when the wood dries the egg is relieved from bark pressure.

On September 19, 1923 in Skull Valley, Arizona, and again on October 26, 1923 near Prescott, Arizona, we found the oak girdled, though at that time there were no insects, as the season was probably too late for them at these higher altitudes.

The stock on the open range is almost wholly dependent on the tender shoots of oak for feed during several winter months. If this insect should multiply as has the mesquite girdler, *Oncideres putator* Thomas, the winter range would be seriously impaired.

HAROLD R. BRISLEY, Plant pathologist, and R. A. CHANNEL,
United Verde Extension Mining Co., Clemenceau, Arizona

Notoxus anchora Hentz apparently feeding on a blister-beetle.—An interesting observation was made by the writer while collecting live blister-beetles, *Macrobasis unicolor* Kirby, on July 18, 1923, near East Lansing, Mich. Most of the adults were very active and flew readily. One of them, however, was quite inactive and made little or no attempt to get away. When the insect was taken a number of adults of *Notoxus anchora* Hentz rushed out from under the elytra. Five of these were cap-

tured while several others escaped. Examination of the blister-beetle under the binoculars showed that the soft connective tissue between the metathorax and the first abdominal segment, dorsally, had apparently been eaten away leaving a ragged edge. It also appeared as if the predators had been feeding on the internal tissue surrounding this opening. In all other respects the blister-beetle appeared to be normal. Whether or not it had been previously injured could not be determined.

L. G. GENTNER, *Mich. Agr. Coll.*

Diabrotica soror Leconte in Colorado.—Miss Le Norma Veque has handed me a spotted beetle recently found about her house in Boulder, Colorado, and it proves to be *D. soror*, the species so common in California. I have Californian specimens from Berkeley and Stanford University. It seems probable that the insect is at least temporarily established in Boulder, as Miss Le Veque found another in her garden last summer. In New Mexico we get *D. 12-punctata*, not *soror*.

T. D. A. COCKERELL

Possibilities of Granular Calcium Cyanide as a Control Measure for Wireworms. Severe infestations of wireworms occurred during May and June, 1923, in fields of early cabbage near Philadelphia. Losses varied from 15% to 49% of the entire stand. In some fields as many as 25 individuals were taken from the roots of a single plant. Neither poison bran bait nor corrosive sublimate solution, 1–1000, resulted in control.

Wireworms were confined in pots of moist soil one, two, three, and four inches below the surface. Five individuals were used in each experiment. Five grams of granular calcium cyanide were placed on the surface of the soil in each pot. When examined after a 48-hour period, one hundred percent kill was found to have been obtained in each of the treated pots while all individuals in the checks were living. The same treatment was then applied in one section of a heavily infested field of cabbage. Six to eight grams of granular calcium cyanide were placed three inches from each plant in a furrow left by cultivation. In some rows, dirt was thrown over the cyanide with a wheel hoe, in other rows the material was left exposed. Within twenty-four hours, the field was watered by an overhead system of irrigation. Five days after application, the plants were examined and an average of 81% kill was found to have been obtained. Twenty dead wireworms and one live individual were taken from one root. No difference in kill was found between the rows in which the material was covered and those in which it was left uncovered. A strong odor of cyanide was distinguishable in the soil five days after treatment. Some injury to the plants resulted from this treatment which may have been due to weakened root systems. Tests to determine the tolerance of plants to various dosages were repeated four times on plants which had been transplanted two weeks and which were not infested with wireworms. No injury resulted from dosages of 5 grams to 10 grams per plant. Plants, treated with 12, 14, and 16 grams respectively, were killed.

J. L. HORSFALL,
Pa. Sta. Col. Laboratory, Bustleton, Pa.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $3.00 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

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The international conference on phytopathology and economic entomology in Holland last June was a notable gathering. It is a source of much gratification that our association was so ably represented and that we can reproduce in this issue a photograph of most of those in attendance. Such gatherings emphasize the essential unity of problems in the various countries and make possible more effective cooperation as a result of better understanding. The recognition of economic entomology as a science independent from phytopathology is in accord with American ideals and, in our estimation, fully justified by the facts, though it is recognized by all that there should be close cooperation between students in both branches.

There are two phases of learning, the technical and the general. The former appeals to the investigator and is adopted to some extent, through necessity, in many commercial activities. Technicalities tend to break the solidarity of a community or group, and to that extent are undesirable. On the other hand they make for greater precision. Specialization in science has gone to such an extent that many in related groups know little of the activities of their associates and the general public even less. It is recognized that many technicalities are unavoidable if there is to be an extension of knowledge, and few would seriously question the wisdom of research. "Science Service" has been doing some notable work in popularizing science. The writer has been lead to suggest that investigators may help in this direction by avoiding unnecessary technicalities in their writings. Not many will read works requiring the constant use of a glossary. Is it fair to compel students in each group of natural science to acquire an extended special vocabularly,

since the time devoted to unnecessary effort along this line is lost for presumably more legitimate effort in mastering the secrets of nature? Is it not possible that a few more pages of generally understood words would in many cases convey the ideas with sufficient exactitude? If so, this would presumably mean more readers and more general appreciation of scientific activities. May we not purchase exactitude at too great a cost? Does a man dying of thirst wish a discourse on hydrogen oxide?

Obituary

Shirley Watson Foster

Mr. Shirley Watson Foster passed away on October 23, 1923. About five days previous to that date, he was taken seriously ill and was operated upon, when a growth was discovered on the lower intestine. The operation was well performed but gangrene spread so rapidly that there was little hope and he never rallied. He is survived by Mrs. Foster and two young children, who have their home at Diablo, California.

Mr. Foster was born near Greensboro, North Carolina, April 8, 1884. He attended the North Carolina State College of Agriculture and later took a special course in Biological Science and Horticulture at Cornell University. In 1907 he entered the United States Department of Agriculture as field Entomologist, under the supervision of Doctor Quaintance and spent a great deal of his time in California, where he became widely known for his valuable discoveries in the control of Pear Thrips, Codling Moth and other orchard problems on the Pacific Coast. The latter part of 1912 he left the Government service to take the position of Entomologist and Manager of the Insecticide Department of the General Chemical Company's Pacific Coast Branch.

Mr. Foster was a man of sterling character and high ideals and although connected with a commercial enterprise, his sincerity of purpose enabled him to give to the fruit growers the sort of advice which represented the most beneficial as well as economical methods; hence the confidence reposed in him by the growers and their district advisers, all of which is tangibly expressed by the many messages of condolence.

Reviews

The Principles of Insect Control by ROBERT A. WARDLE and PHILIP BUCKLE, pages i–xvi, 1–295, 32 text figures. Manchester: At the University Press, London, New York, etc., Longmans, Green and Co., 1923.

This volume gives a very readable account of the various phases of insect control, devoting a chapter to each of the following topics: Host Resistance, Climatic Restriants, Disease, Parasites and Predators, Bird Encouragement, Insecticides (3 chapters), Dips and Dressings, Attractants and Repellents, Fumigants, Cultural Methods, Restriction of Spread, Crop Storage, Baits and Traps, Legislation and Machinery.

This is a valuable and comprehensive resumé, world wide in scope, of recent literature, since it summarized within the confines of a small volume the essentials of a host of contributions. There is a separate and well selected bibliography for each of the chapters, consequently it is a very handy reference work in all fields of economic entomology. It should be in the hands of entomologists, in entomological libraries and in many of the general libraries of the country. E. P. F.

External Insect Anatomy, A Guide to Study of Insect Anatomy and an Introduction to Systematic Entomology by ALEX. D. MACGILLIVRAY. Pages i–x, 1–388, 142 text illustrations. Urbana, Illinois, Scarab Company, 1923.

The volume is a comprehensive guide to the external anatomy of adult insects and although we may not agree with the author in all matters relating to terminology, it is a fact that no student can take the course outlined in this guide without gaining a very good idea of insect structure, something essential in both economic and systematic entomology.

The general reader may be "delighted" with such terms as: alacoxasuture, antacava, antarolium, cephacoria, cervasternum, dexaparamere, distavalvaria, lateroclypeus, linguacuta, maxillaria, mesowing, octavalvae and many others, some at least unknown to makers of technical dictionaries. We doubt it. Nearly a page, for example, of this precise, presumably concise, language is devoted to a description of the mesonotum of *Blatta orientalis* and about as much more to the metanotum. The carrying of terminology to such an extreme raises a serious question in the reviewer's mind. Are we entering a period when it will be necessary for a student to master an extended terminology in each of the numerous branches of science? Presumably some of the new terms will be accepted as necessary. Others may be discarded, since it is possible that the difficulties of mastering such technical matter may offset any gain in conciseness and clarity, both desirable, though they should not be purchased at too great a cost.

The selection of types for study is excellent, most of them being relatively common forms and therefore easy to obtain. The volume represents a vast amount of careful, exacting work. It contains much of value to the student of morphology, though it is regrettable that the internal anatomy and the structure of the immature stages have not been worked out in a similar comprehensive manner. The volume is an extended authentic, contribution on the external anatomy of insects. Those giving courses in this subject should have this stimulating work at hand. It covers a field not hitherto adequately discussed. E. P. F.

Current Notes

Mr. W. B. Williams of the Tallulah, La., laboratory of the Bureau of Entomology has resigned to enter private business.

Mr. Harold B. Cook, graduate assistant in Zoology and Entomology at Iowa State College, has accepted an instructorship in Physiology at Tulane University.

Dr. W. M. Wheeler, Dean of the Bussey Institution, Harvard University, delivered an address, December 8, 1923, on "Social Insects," at Toronto before the Royal Canadian Institute.

Messrs. W. Carter and H. E. Gray, of the Lethbridge laboratory, Canadian Entomological Branch, are now engaged in post-graduate studies at the Universities of Minnesota and Montana, respectively.

Mr. E. W. Dunman, a graduate student in Zoology and Entomology at Iowa State College, has accepted a position as assistant professor of Zoology and Entomology at Louisiana State University.

The following were elected officers of the Ontario Entomological Society for the year 1924: President, J. M. Swaine; Vice-president, R. C. Treherne; Secretary-Treasurer, A. W. Baker; Editor, Canadian Entomologist, J. H. McDunnough.

Mr. Philip Spong, graduate assistant in Zoology and Entomology at Iowa State College, has accepted the position as head of department of Biology of Nebraska State Teachers College, Wayne, Nebraska.

According to *Entomological News*, Mr. Philip Nell, an associate of the Entomological Section of the Academy of Natural Sciences since 1891, died at his home in Philadelphia, November 7, 1923.

Mr. W. S. Hough, Assistant Entomologist to the Crop Pest Office and Experiment Station, Blacksburg, Virginia, has secured a leave of absence for this quarter and is taking graduate work in the Department of Entomology at Ohio State University.

Mr. S. W. Frost of Arendtsville, Penn., is spending a few weeks in the entomological laboratories of Cornell, rounding out his investigations of the Dipterous and Coleopterous leaf miners.

Mr. H. L. Viereck of Washington is at Cornell for a few weeks working on the collection of saw flies, naming the undetermined species, rearranging and putting the material in order.

Prof. and Mrs. J. H. Comstock have left Ithaca for an extended visit to the Southwest and to California. They will spend the major portion of their time in Palo Alto.

Mr. Arthur Gibson, Dominion Entomologist, addressed the McGill Agricultural Graduate Club at Macdonald College, Que., on the evening of November 7, the subject being "Recent Developments in Entomology in Canada."

Prof. James G. Needham delivered the annual public address before the Entomological Society of America, Saturday evening December 29, at Cincinnati, Ohio, on "The Rôle of Insects in Food Production."

Mr. T. C. Barber of the Bureau of Entomology traveled in northeastern Mexico during November, investigating sugar-cane insects and making a general collection of the insects of economic importance in that region.

Messrs. W. R. Walton and L. H. Worthley of the Bureau of Entomology visited Brooklyn, N. Y., November 23 to inspect an area near Fort Hamilton which recently has become infested with the European corn borer.

The Cross of Chevalier of the Legion of Honor has recently been awarded by the French Government to Dr. L. O. Howard, Chief of the Bureau of Entomology, in recognition of his services to world agriculture.

Messrs. L. L. Huber and C. R. Neiswander of the Ohio Station visited Arlington, Mass., October 11, 12 and 13, studying the methods pursued at the Federal European Corn Borer Laboratory, especially the breeding of parasites.

The final scenes for a new motion picture film on the corn borer adapted to middle western conditions were taken in Ohio during the week of November 26. This film is prepared by the Bureau of Entomology.

Mr. A. E. Miller has gone to Washington for six or eight weeks to study the collection of mites he has gathered in Ohio. Dr. H. E. Ewing of the United States Department of Agriculture will assist in this study.

The Bureau of Entomology's storehouse and motor base for the corn borer quarantine control work in the Middle West has been transferred from Toledo, Ohio, to the corner of Clark and Kipling Streets, Elyria, Ohio. Mr. C. E. Towle will be in charge.

Dr. E. D. Ball, Director of scientific work of the U. S. Department of Agriculture, attended the sessions of the Association of Land Grant Colleges at Chicago, and on November 14, was one of the speakers at a luncheon of the Chicago Department Club, at the Great Northern Hotel.

Mr. S. W. Frost of Arendtsville, Pa., spent a week in Washington recently working with Dr. Boving on leaf-mining coleopterous larvae. Mr. Frost has made a specialty of the study of leaf-miners, and hopes to have an opportunity to study the preserved material and slides in the National Collection.

Mr. A. E. Miller of the Ohio Station who spent the summer of 1919 in Alaska with an exploring party of naturalists, gave a lecture on the "Valley of Ten Thousand Smokes" before the Kiwanis Club of Wooster, November 20, Lion's Club of Akron, November 27, and Kiwanis Club of Medina, November 30.

Mr. C. C. Hamilton of the University of Maryland, who recently completed an arrangement of the collection of the immature stages of *Cicindela*, is continuing his work on the immature stages of the larvae of the beetle family Carabidae. He is spending one day a week in the Division of Insects, U. S. National Museum.

Mr. A. E. Miller of the Ohio Station scouted Jackson, Gallia, Ross, and Pike Counties, Ohio, and found evidence of the work of the Mexican Bean Beetle in all of them. The pest will probably cause considerable damage to string beans in these counties next summer and the damage is expected to be severe the following summer.

Mr. J. D. Hood, Instructor in the University of Rochester, Rochester, N. Y., has recently removed his magnificent collection of Thysanoptera to Rochester and is now giving considerable time to the study of his favorite group of insects. The collection is exceptionally rich in types and contains material from all parts of the world, many species being represented by considerable series.

Dr. E. O. Essig of the California Agricultural Experiment Station, Berkeley, Calif., visited the Division of Insects, U. S. National Museum, for a few hours November 27. Dr. Essig is especially interested in methods of arranging collections, types

of cases, and the amount of material represented in various groups, and also was glad of the opportunity to become acquainted with various workers in the Division.

Prof. H. A. Gossard of the Ohio Station was an invited guest at a luncheon of the Ohio Botanic Garden Society, given at the Queen City Club, Cincinnati, December 28. This luncheon was projected as an initial step toward establishing at Cincinnati a Botanic Garden which is expected eventually to equal any in America. An address was given by Dr. C. S. Gager, Director of the Botanic Garden, Brooklyn, New York.

Mr. Roger B. Friend, a graduate of Massachusetts Agricultural College, class of 1923, who has been employed by the New York Conservation Commissioner, under Dr. E. P. Felt, Albany, on gipsy moth work since graduation, has been appointed Assistant in Entomology at the Connecticut Agricultural Experiment Station, New Haven. At first Mr. Friend will serve on a part time basis while working for a doctor's degree in Yale University.

Mr. E. G. Smyth of the Bureau of Entomology has just returned to Washington from Mexico and Guatemala, where he was engaged in collecting and shipping parasites of the Mexican bean beetle. Though Mr. Smyth did not discover any new parasites of this insect, he collected near Mexico City large numbers of a tachinid. Some of the parasites were sent to the Western Station in New Mexico for hibernation, but most of them were shipped to Birmingham, Ala.

Mr. Walter W. Froggatt having reached the age limit of 65, retired on June 13, 1923, as Government Entomologist to the Department of Agriculture of New South Wales, Australia, but has accumulated a long leave that will keep him in the service until June 18, 1924, when he will retire on pension. He has recently been appointed special forest entomologist under the Australian Forestry Commission to investigate the lumber borers of Australia, a matter now assuming much prominence with lumber merchants, architects and builders.

Dr. M. W. Blackman of the New York State College of Forestry, recently spent several days in Washington conferring with officials of the Division of Forest Insects and examining types of Scolytidae. It was agreed that closer understanding of the respective forest insect investigations conducted by the New York State College of Forestry and the Division of Forest Insects of the Bureau of Entomology would be of benefit to both institutions. Dr. Blackman has undertaken to assist the Division of Forest Insects in the determination of Scolytidae.

The collection of exotic coleopterous larvae in the U. S. National Museum has recently been rearranged and labelled in conformity with the Heyden, Reitter, and Weise catalogues of Coleoptera. The bulk of this exotic material comes from Europe. The collection occupies 1,185 vials, and the rearrangement has taken about six months. The work has been done by Mrs. Nellie McConnell under the direction of Dr. Boving. Dr. Boving has recently received as a loan for comparison with North American forms four elaterid larvae from Denmark, and he and Mr. Hyslop are continuing their work on the arrangement and classification of the elaterid larvae in the collection.

During November, 1923, Mr. J. C. Hamlin, in charge of the scientific work of the Australian Commonwealth Prickly Pear Board, conducted an expedition into Mexico in search of important insect enemies of cactus. The party included Mr. E. Mortensen, Assistant Entomologist, Mrs. Hamlin, and Miss Marie MacKinnon, daughter

of the Australian Commissioner to the United States. The points visited include Monterey, San Luis Potosi, Cuernavaca, San Juan de Teotihuacán, Mexico City and vicinity, Tampico, and Victoria. At least three important cactus insects not occurring in the United States were found.

Prof. Geo. A. Dean of the Bureau of Entomology has just returned from an extended trip, during which he visited the field stations of Cereal and Forage Insect Investigations at Arlington, Mass., Silver Creek, N. Y., Sandusky, Ohio, Charlottesville, Va., LaFayette, Ind., Centralia, Ill., Webster Grove, Mo., Wichita, Kans., Salt Lake City, Utah, Billings, Mont., Ritzville, Wash., Forest Grove, Oreg., Sacramento, Calif., Tempe, Ariz., and San Antonio, Texas. He also visited many of the departments of entomology of the agricultural colleges and State universities, and had conferences with entomologists and with the directors of the experiment stations of many of the States. In all of the places visited and at the conferences attended he found a deep interest in entomological work and a splendid spirit of willingness to enter into cooperative work.

According to *Entomological News*, Mr. Edgar L. Dickerson died at Passaic, N. J., October 30, 1923. Mr. Dickerson graduated from Rutgers College in 1902, and from the time of his graduation until 1911, he served as an assistant in the State Board of Agriculture under the late Professor John B. Smith, when he resigned to enter the biological department of the Barringer High School, Newark, N. J. In February 1912, he commenced teaching biology at the Central High School of Newark, where he remained until his death, being promoted to head of the department of Biological Sciences and Commercial Geography, some four or five years ago. An obituary notice with a list of Mr. Dickerson's entomological papers, by Mr. Harry B. Weiss, may be found in *Entomological News* for January 1924, Vol. XXXV, page 35.

Dr. F. C. Craighead, Bureau of Entomology, left Washington November 25 to attend a conference of the western field men at Klamath Falls, Oregon. The program involves a review of recent control projects and the results obtained, also a discussion of epidemics of defoliating insects which are causing extensive losses at several points in the west. Forest insect surveys, including estimates of the annual losses caused by bark beetles and special investigations on various phases of control, cycles of outbreaks, etc., will be considered. En route to Klamath Falls, Dr. Craighead planned to stop at the Minnesota Agricultural Experiment Station, St. Paul, Minn., to confer with Dr. Wm. A. Riley and Dr. S. A. Graham, and with Mr. R. Zon of the Forest Service Experiment Station regarding investigations on forest insects in the Lake States in cooperation with these institutions.

"The Status of Entomology in Porto Rico," a paper prepared by Mr. G. N. Wolcott for presentation at the meeting of the American Association of Economic Entomologists at Toronto in 1921, but due to his absence read only by title, has recently been published as No. 2, Vol. VI, of the Journal of the Department of Agriculture and Labor of Porto Rico. It forms one of a triology of publications attempting to summarize the entomology of Porto Rico, the others of the series being "Insectae Portoricensis, a Preliminary Annotated List of the Insects of Porto Rico with descriptions of some New Species," which will appear as No. 1, Vol. VII of the JOURNAL, and "Entomología Económica de Puerto Rico" (in Spanish), Bulletin No. 33 of the Insular Experiment Station, Rio Piedras, P. R.

Mr. Harry W. Vinton, who was employed in the Bureau of Entomology for more than 17 years, died at Pittsfield, Mass., October 29, 1923. About two years ago, Mr. Vinton suffered a severe attack of pneumonia and since that time has steadily declined in health, although he was able to attend to his duties until last July. Throughout his long employment with the Bureau, Mr. Vinton worked on the Gipsy Moth and Brown-tail Moth project. He was made first assistant to the officer in charge of field control work against these insects when work was begun by the Bureau in 1906. In 1913 he was assigned to the position of first assistant in the quarantine section of the moth work and retained this position up to the time of his death. Prior to his employment with the Bureau, Mr. Vinton served the State of Massachusetts in various capacities in the work conducted by that State against the gipsy moth and the brown-tail moth, having begun his employment with the State in April, 1893. Being naturally observant and interested in insect and bird life, Mr. Vinton became well acquainted with many of the New England species. His ability and long experience in field operations, including quarantine work, made him an especially valuable and efficient employee. His loss to the Bureau is greatly regretted by all those who knew him.

The Civil Governor of Kwongtung Province, South China, has authorized the organization of a bureau for the Improvement of Sericulture in that Province. The Bureau is known as the Kwongtung Provincial Bureau for the Improvement of Sericulture and has its Head Offices located on the campus of the Canton Christian College, with the Head of the Department of Sericulture of that College, C. W. Howard, as the Director of the Bureau. The close affiliation of the Bureau and the College Department of Sericulture it is expected will strengthen this government work as the college has for the past five years been actively working along these lines among the silk farmers of South China, and has created an active demand for the extension and instructional work which they will be able to do. The Bureau will have power to supervise all production of certified silk worm eggs in the Province and to license all egg producers and merchants, as well as put into force any measures which it may think wise to improve the production and reeling of silk worm cocoons or growing of mulberries. It is supported by an ample appropriation from the government. Kwontung is the largest center for the production of raw silk in China, exporting each year twice as much steam filature raw silk as Shanghai which draws its product from the entire Yangtse Valley. If the industry can be put onto a modern scientfic basis the output from South China can be increased by four to five times. The placing of this task of improving their largest single industry into the hands of foreign experts speaks well for the progressive spirit of the South Chinese.

A Pea Aphis Conference held at Washington, D. C., November 20 and 21, 1923, was called primarily to continue the cooperative work initiated at Chicago last year, to review the accomplishments of the past season, and to make plans for further work. Representatives from the entomological departments of the important pea-canning states were present, in addition to pea canners, entomologists of some of the insecticide companies, and members of the Bureau of Entomology. The state representatives included J. J. Davis, T. J. Headlee, P. J. Parrott, E. N. Cory, W. P. Flint, E. O. Essig, C. L. Fluke, Herbert Spencer, C. C. Hamilton, G. S. Langford, and S. F. Potts. The insecticide companies were represented by Wiliam Moore, G. F. Leonard, and F. J. Sutton. Representatives of pea canners at this meeting included C. G. Woodbury, W. E. Nicholoy, J. P. Street, H. P. Cannon, J. W. Deniger, and W. E. Spencer.

The Bureau of Entomology was represented by W. H. White, C. H. Popenoe, J. E. Dudley, Jr., and J. E. Graf. In addition to these, there were present at some of the sessions visitors from the Department and the Bureau of Entomology. These included E. D. Ball, L. O. Howard, W. R. Walton, A. C. Baker, and J. A. Hyslop. During this conference it was found that considerable confusion resulted from the different methods used in expressing the strengths of nicotine dusts. It was learned that in the East the nicotine dust is expressed in terms of the percentage of pure nicotine included, while in the West the percentage of 40 per cent nicotine is given. After a discussion of this subject, it was decided that in order to avoid confusion all publications mentioning nicotine dust should have the strength stated in terms of pure nicotine, and, in addition to this, the formula should state whether free nicotine or nicotine sulphate was used.

The eighteenth meeting of the Entomological Society of America was held in Cincinnati, Ohio, December 27, 28, 29, 1923. It was one of the busiest and best attended meetings ever held by the Society. There were six sessions: three for the presentation of contributions, one for the annual public address, while two sessions were occupied by the business meeting and the Symposium. Attendance at the several sessions ranged from 75 to about 200. Professor T. D. A. Cockerell of the University of Colorado presided throughout the meeting. The subject of the Symposium was "Methods of Protection and Defense among Insects." Dr. James G. Needham of Cornell University delivered the public address under the title "The Rôle of Insects in Food Production." He presented a much neglected phase of Entomology. Sixty-four new members were elected to the Society. The following officers were elected for the year 1924: *President*, Chas. W. Johnson, Boston Society of Natural History; *First Vice-President*, W. E. Britton, Connecticut Agricultural Experiment Station; *Second Vice-President*, C. T. Brues, Bussey Institution, Harvard University; *Secretary-Treasurer*, C. L. Metcalf, University of Illinois; *Managing Editor of the Annals*, Herbert Osborn, Ohio State University; *Executive Committee*, Arthur Gibson, T. D. A. Cockerell, J. H. Emerton, Edith M. Patch, and W. D. Funkhouser; *Councilors to the A. A. A. S.*, P. P. Calvert, and James G. Needham; *New Members of the Editorial Board*, Wm. Schaus, W. E. Britton, and E. C. Van Dyke; *New Member of the Thomas Say Foundation*, J. Chester Bradley.

ANNUAL CONFERENCE OF EXTENSION ENTOMOLOGISTS 1923

The conference was held in Hotel Gibson, Cincinnati, Monday evening December 31, 1923. Chairman Kelly called the meeting to order and presided. H. E. Hodgkiss acted as secretary for the meeting, 59 Entomologists being present.

Mr. Kelley opened the meeting with a general discussion of extension work with particular reference to Kansas conditions. Mr. Hodgkiss was called on for a talk on methods. Mr. Ford of S. Dakota told what he considered to be a demonstration. Mr. A. L. Strand was called on to illustrate differences between western and eastern methods in Extension Entomology. Mr. Lockwood spoke at length on the forecasting of insect outbreaks. Mr. Parks discussed methods and lining up of work.

Following these talks the meeting was opened for general discussion which was participated in by Messrs. Flint, Gibson, Cooley, Gillette, Kelly, Gossard, Chandler, Dean, Caesar, Dr. Hinds, Quaintance, and Phillips.

The following officers were elected for the ensuing year. Chairman, H. E. Hodgkiss, Secretary, T. H. Parks.

The chairman called for an expression on the holding of a similar meeting at the next session of the society. It was voted unanimously to hold such a session. Meeting adjourned.

H. E. Hodgkiss, *Acting Secretary*

Rocky Mountain Conference of Entomologists

The Rocky Mountain Conference of Entomologists held at Pingree Park, Colorado August 20 to 26, under the auspices of the Department of Entomology, Colorado Agricultural College, proved a complete success. All were of the opinion that the week was a very profitable one and it certainly was a pleasurable one for not only the entomologists, but for the members of their families that were present as well.

Pingree Park is a beautiful mountain park, little developed as yet, located about 50 miles by auto from Fort Collins, and at altitude of about 9000 feet. A number of beautiful streams and lakes that are accessible afford good trout fishing, and opportunities for mountain hikes and horseback trips are unlimited. Some beautiful trails lead to snow and a natural glacier within a few hours time.

The Colorado Agricultural College owns a lodge in these interesting surroundings for the students of forestry. This was made headquarters for the meetings.

During the week a part of each day was given to enjoying these wonders of nature, in insect collection, contests of various kinds, and in having a general good time. Two daily business sessions were held, usually one in the afternoon and the other in the evening around the big fire place in the lodge. The meetings being very informal resulted in such free discussion that the week was too short for the entire program and the many calls offered by the park and mountains. The following subjects were discussed:

Some Observations on Mendelian Inheritance in Coccinellidae . . Miss M. A. Palmer
Alfalfa Insects in Kansas . . . . Roger C. Smith
New Developments in Alfalfa Weevil Control in Idaho . . . . Claude Wakeland
Alfalfa Weevil Control in Colorado . . . . J. H. Newton
The Relation Between Scientific Investigators and Commercial Concerns . . . . E. A. Pearson
The European Earwig in Oregon . . . . A. L. Lovett
Beekeeping in North Dakota . . . . R. L. Webster
Some problems of Beekeeping in Colorado . . . . Newton Boggs
Syrphid Flies . . . . C. R. Jones
The Mexican Bean Beetle . . . . George M. List
Infectious Anaemia in Horses with Special Reference to Insect Transmission . . . . J. W. Scott
Teaching of Entomology to Agricultural Students Specializing in Other Lines.
General Discussion opened by . . . . Roger C. Smith
Hessian Fly Control in Iowa . . . . Carl J. Drake and F. A. Fenton
Sugar Beet Leaf Hopper in Idaho . . . . A. C. Maxson
Control of Eleodes in Idaho . . . . Claude Wakeland
Eleodes in Colorado . . . . J. L. Hoerner
The Potato Flea Beetle . . . . J. L. Hoerner
The Mormon Cricket . . . . C. L. Corkins
Codling Moth . . . . George M. List
Rate of Growth of Apples in Relation to Codling Moth Control . . Wm. P. Yetter, Jr.

Trapping the Adult Codling Moth..........J. H. Newton and Wm. P. Yetter, Jr.
Uniform Procedure in Grasshopper Control Experiments.......Steward Lockwood

Mr. A. C. Maxson was adjudged winner of the trout fishing contest, with A. L. Lovett taking the booby prize. This contest furnished mountain trout for the entire crowd five mornings of the week, to say nothing of the good sport, blistered heels and wet feet. Mr. J. H Hoerner won the men's singles in horseshoe pitching and Miss McDonald the women's singles. Colorado took the doubles. Dr. Carl J. Drake was pronounced the champion "bug" catcher. The impromptu entertainments put on after the evening meetings revealed much talent and were greatly enjoyed by all.

All entomologists in attendance and members of their families were unanimous in their request that the Conference be held again in 1924 and at the same place. To make plans for this an informal organization was formed with C. P. Gillette, Chairman; Myron H. Swenk, Vice-Chairman and George M. List, Secretary and Treasurer. A number have already notified us that they are looking forward to this as a vacation trip for themselves and families. It is very probable that the dates will be August 18–23, inclusive.

George M. List,
Secretary-Treasurer

The Second Pan-Pacific Science Congress

The Second Pan-Pacific Science Congress was held in Australia, August 13 to September 3, 1923. Sessions were held at Melbourne, August 13–22, and at Sydney, August 23 to September 3. There were about 80 overseas delegates, and 100 or more Australian scientists were in attendance. The overseas delegates were from Great Britain, Canada, United States, Hawaii, Fiji, New Zealand, Japan, Philippines, Malay States and Java. Six of the delegates were entomologists: Dr. Guy A. K. Marshall, Director of the Imperial Bureau of Entomology, London; O. H. Swezey, Entomologist of the Hawaiian Sugar Planters' Experiment Station, Honolulu; E. M. Ehrhorn, Chief Plant Inspector, Honolulu; Robert Veitch, Entomologist to the Colonial Sugar Refining Co., Lautoka, Fiji; Dr. R. J. Tillyard, Entomologist, Cawthorn Institute, Nelson, New Zealand; Dr. M. Oshima, Institute of Science, Formosa.

The sessions of the Congress were held in eleven different sections: (1) Agriculture, (2) Anthropology and Ethnology, (3) Botany, (4) Entomology, (5) Forestry, (6) Geodesy, Geophysics and Radiotelegraphy, (7) Geography and Oceanography, (8) Geology, (9) Hygiene, (10) Veterinary Science, (11) Zoology. Each section carried on its own sessions with papers and discussions appropriate to each. There were many joint sessions of closely related sections. There were a number of field excursions by the different sections to places of interest, or where there were demonstrations of matters of importance to the respective sections.

The section on Entomology had a very full program with a long list of papers on subjects including sugar cane pests, cotton pests, orchard pests including fruitfly, cattle insects, sheep blowfly, timber borers, termites and cactus insects. In the papers and discussions of the various pests, much time was given to the conditions prevalent in Australia, history and habits of the pests considered, injury by them, and methods of combating them. Introduction and use of beneficial insects was given a good deal of prominence; instances of success by this method were given. The writer presented a paper showing benefits derived in Hawaii in control of sugar cane

pests by the introduction of their natural enemies. Dr. Tillyard cited several successful introductions into New Zealand, among them being the introduction of *Aphelinus mali* from the United States, which has become very useful against the woolly aphis. The importance of horticultural quarantine and plant pest legislation were also subjects that had a place in the entomological program.

A popular feature of the Congress was the series of public evening lectures, which were attended by large audiences, the spacious public halls used being packed to the doors. These lectures were mostly illustrated with lantern slides, subjects being as follows:

The Interior of the Earth. By Professor W. H. Hobbs, University of Michigan.

The Desert Peoples of Central Asia. By Dr. Ellsworth Huntington, Yale University.

The Mystery of Easter Island. By Professor J. Macmillan Brown, University of New Zealand.

Hawaii, A Romance of Science in the Pacific. By Dr. H. E. Gregory, Bishop Museum, Honolulu.

The Romance of Maori Life and Culture. By Dr. P. H. Buck, Governor Medical Officer to Maoris.

The Migration of Peoples in the Southwest Pacific. By Dr. A. C. Haddon, Royal Society of London.

The Philippines, Their People and Resources. By Dr. E. D. Merrill, Bureau of Science, Manila.

The next meeting, or Third Pan-Pacific Science Congress is to be in Japan in 1926.

O. H. Swezey

Horticultural Inspection Notes

The Alfalfa Weevil was the subject of a conference in Washington on January 5. Means of retarding the further spread of the insect were discussed.

Mr. A. J. Bruman of the Washington inspection force, spent three weeks in New York recently, assisting in the inspection of shipments of Almeria grapes arriving at that port.

Mr. P. A. Glick, who was recently appointed as Plant Quarantine inspector in the Federal Horticultural Board and stationed at Philadelphia, has been transferred to the port of New York.

Mr. Max Kisliuk, who is in charge of the work of the Federal Horticultural Board in Philadelphia, is again able to take up his duties after a severe illness.

Mr. E. R. Sasscer and Mr. L. A. Strong left Washington on December 6 to visit the ports of New York and Boston for the purpose of studying conditions relating to the inspection work at these points.

Mr. Emile Kostal, who is assigned to the Inspection Service in New York, made a trip to Boston during the first part of December to assist in the inspection of grapes arirving at that port from Almeria, Spain.

Mr. William Shemin has been appointed to the position of Plant Quarantine Inspector in the Federal Horticultural Board, beginning December 17, with headquarters at Philadelphia. He is a cousin of Ralph Shemin, who holds a similar position in New York.

Mr. E. I. Smith of the Inspection Service in Washington is being assigned to duty

at Seattle, Washington, where he will assist Mr. Webb in carrying on the work of the Federal Horticultural Board. He will reach Seattle about January 24.

Mr. H. Meerscheidt, a graduate of the New Mexico A. & M. College, has been appointed by the Federal Horticultural Board with assignment at Nogales, Arizona, where he will assist in the fumigation of all cars requiring such treatment as a condition on entry.

Mr. O. A. Pratt attended the convention of the California Fruit Growers and Farmers held at Santa Ana, California, on December 6 and 7. Mr. Pratt has for some time been in charge of the work of the Federal Horticultural Board at Calexico, California.

Mr. A. A. Stalmach, who for the past three years has been stationed at Nogales, Arizona, was recently transferred to Laredo, Texas, to assist in the inspection, certification, and fumigation of railway cars, in accordance with the rules and regulations of the Federal Horticultural Board.

Dr. C. L. Marlatt attended a combined meeting of the Chestnut Hill Garden Society and other similar organizations from nearby points at Chestnut Hill, Massachusetts, on November 8. He gave an address on the subject of Federal Plant Quarantines, with special reference to Quarantine No. 37.

The officials and employees of the Federal Horticultural Board who attended the meetings of various organizations connected with the American Association for the Advancement of Science in Cincinnati were Drs. C. L. Marlatt and W. A. Orton; and Messrs. E. R. Sasscer, R. K. Beattie, and L. A. Strong.

Mr. H. Y. Gouldman, an inspector of the Federal Horticultural Board stationed in Washington, spent several days during the latter part of November and the first part of December in New York and Philadelphia, assisting in the inspection of shipments of grapes coming to this country from Almeria, Spain.

Dr. James R. Weir of the office of Forest Pathology, who is traveling in South America and the West Indies for the Bureau of Plant Industry, has been authorized to make an investigation of the diseases in these countries, which might become serious if introduced into the United States.

Dr. William M. Mann of the Bureau of Entomology, is making an investigation for the Federal Horticultural Board, of the fruit flies and other injurious insects attacking fruits and vegetables in Mexico, Central America, and Colombia. Dr. Mann left Washington about September 17, and will probably not return for several weeks.

The Satin Moth Quarantine has been amended effective November 15th to include a slightly larger area in Massacusetts and New Hampshire than that covered by the original Quarantine Order, which went into effect on January 1, 1922. The spread of the insect which made such action necessary is regarded by the officials of the Board as being "fairly inconsiderable."

Mr. Lee A. Strong, who for several years has served in the capacity of Chief of the Bureau of Plant Qurantine in California, has resigned his position to accept an appointment with the Federal Horticultural Board with headquarters at Washington. Mr. Strong, because of his experience in quarantine matters, is well fitted to conduct the work which has been assigned to him by the Board.

Hearings were held in Washington on January 4th relative to the extension of the

Japanese Beetle Quarantine and to the exclusion of Christmas trees. A conference was also held to discuss the question of what action should be taken in regard to future shipments of grapes from Spain because of the danger of introducing the Mediterranean Fruit Fly.

The following entomologists attended the hearing: Geo. G. Becker, Chief Inspector, State Plant Board, Little Rock, Ark.; Henry Bird, Consulting Entomologist, Rye, N. Y.; A. F. Burgess, Bureau of Entomology; Curtis P. Clausen, Bureau of Entomology; E. N. Cory, State Entomologist, College Park, Md.; S. B. Fracker, State Entomologist, Madison, Wis.; Arthur Gibson, Dominion Entomologist, Department of Agriculture, Ottawa, Canada; C. P. Gillette, State Entomologist, Fort Collins, Colo.; P. A. Glenn, Chief Plant Inspector, Urbana, Ill.; C. H. Hadley, Director, Bureau of Plant Industry, Harrisburg, Pa.; C. C. Hamilton, Associate Entomologist, College Park, Md.; Thomas J. Headlee, State Entomologist, New Brunswick, N. J.; D. L. King, Bureau of Entomology; S. J. Hunter, Head, Department of Entomology, University of Kansas, Lawrence, Kans.; M. D. Leonard, State Entomologist, Albany, N. Y.; H. L. McIntyre, Supervisor Gipsy Moth Work, Conservation Commission, Albany, N. Y.; L. S. McLaine, Chief, Division Foreign Pests Suppression, Department, of Agriculture, Ottawa, Canada; Wilmon Newell, Plant Commissioner, Gainesville, Fla.; A. L. Quaintance, Bureau of Entomology; E. R. Sasscer, Federal Horticultural Board; L. B. Smith, Entomologist in Charge, Japanese Beetle Project, Riverton, N. J.; C. W. Stockwell, Plant Quarantine Inspector, Riverton, N. J.; Frank N. Wallace, State Entomologist, Indianapolis, Ind.; and W. B. Wood, Federal Horticultural Board.

Secretary of Agriculture Wallace has authorized, as a protective measure, the prohibition of the further entry of Malaga (Almeria) grapes on account of the danger from infestation with Mediterranean fruit fly.

Notes on Apiculture

The American Honey Producers' League will meet in Chicago on January 24th to 25th.

Dr. E. F. Phillips is to take part in a two day educational meeting for beekeepers at Carbondale, Illinois, February 20th and 21st.

Mr. James I. Hambleton and Dr. E. F. Phillips attended a meeting of the Maryland State Beekeepers' Association in Baltimore on January 9th.

Prof. C. L. Fluke, Professor in Entomology, University of Wisconsin, was a recent visitor at the Bee Culture Laboratory of the Bureau of Entomology.

Purdue University is planning a short course in beekeeping to be given February 11th to 14th at Lafayette, Indiana, under the direction of Prof. J. J. Davis.

Dr. E. F. Phillips of the Bureau of Entomology attended a series of meetings of beekeepers in North Dakota, South Dakota, Montana, Wyoming, Colorado and Illinois in November.

A circuit of State Beekeepers' Association meetings, at which Mr. James I. Hambleton is to speak, is scheduled beginning January 12th for Richmond, Virginia, Morgantown, West Virginia, and Harrisburg, Pennsylvania.

The University of Illinois is planning two short courses in beekeeping, one at Urbana, January 23rd to 25th, and the second at Carbondale, February 20th and 21st. These courses are planned by Prof. Wallace Park of the University.

Mr. W. J. Nolan of the Bureau of Entomology left the first week in December for a short trip to Europe. While abroad he intends to meet some of the leaders in scientific apicultural work in France, Czecho-slovakia, Switzerland, Austria and Germany.

Dr. A. P. Sturtevant who resigned from the Bee Culture Laboratory of the Bureau of Entomology, to accept the position of Assistant Professor of Bacteriology in the New York Homeopathic Medical College, has returned to Washington, and resumed his work on bee diseases.

The Australian Government some time ago prohibited importation of adult bees to prevent the introduction of serious diseases of adult bees such as the Isle of Wight disease. An exception is made of the United States, this being the only country from which importations are permitted.

A short course in Horticulture and Beekeeping will be given at the North Dakota Agricultural College during the week beginning February 11th. Although this is given primarily for beginners in beekeeping, the work will include much of value to those with more experience. Mr. L. T. Floyd, from the Manitoba Agricultural College will assist in the teaching work.

The VII International Apicultural Congress will be held at Quebec on September 1st to 4th. Arrangements have been made for reduced railroad rates from various points in the United States and Canada. The preliminary program has been issued and copies may be obtained from M. C. Vaillancourt, Ministry of Agriculture of the Province of Quebec, Quebec. The final program will be issued in June and any suggestions for the program should reach the local secretary before that time. Arrangements have been made for the membership of individuals and societies to this Congress and the rates may be obtained from the Secretary. There will probably be a good attendance of beekeepers and investigators at this Congress, which is the first such Congress held in North America for many years. Mr. C. P. Dadant, editor of the American Bee Journal, Hamilton, Illinois, is the Vice-president of the Congress for the United States. Papers will be read in either French or English.

Pacific Slope Notes

Dr. A. L. Melander, State College, Pullman, Washington, has been elected one of three councilors of the newly formed Northwest Scientific Association.

Messrs. H. M. Armitage, Entomologist, and A. J. Basinger and Harold Compere, Assistant Entomologists, formerly of the State Department of Agriculture, have been transferred to the Whittier laboratory of the California Agricultural Experiment Station, which has taken over the work on the biological control of insects.

Notes on Medical Entomology

According to *Science*, Dr. Asa C. Chandler has resigned from the Rice Institute, Houston, Texas, to accept a position as head of the department of helminthology in the School of Tropical Medicine at Calcutta, where he will devote most of his time to research on the hookworm disease. Dr. Chandler will sail for India early in January.

According to the Public Health Reports of December 21, a number of cases of dengue are still being reported in Texas and Arkansas. It is noteworthy that no cases have developed through the season in the southeastern states.

Mr. N. G. Wessels of the Union of South Africa is spending some time in Texas studying the Angora goat industry in all its aspects. Owing to his interest in the

question of the control of insects which affect goats he is spending some time at the laboratories of the Bureau of Entomology at Uvalde, Sonora and Dallas where work on insects affecting goats is being carried out.

Sir Arnold Theiler, Director of Veterinary Research of the Union of South Africa toured the United States during the fall. He visited a number of universities and experiment stations where he conferred with investigators and delivered a number of lectures. He will be remembered among entomologists especially for his research on the disease bearing ticks of South Africa. While in Texas he reviewed the research work on the loin disease of cattle and confirmed the diagnosis of American investigators who considered it identical with lamziekte of South Africa, a disease produced by organisms taken in by the stock while chewing bones and not insect borne as thought by some. Sir Arnold began his homeward voyage from San Francisco during November.

Squash Pest. Late in the summer of 1921 a coccinellid colony was found completely devouring foliage of squash and water melon vines in one garden close to the Mexican boundary and near Douglas, Arizona. In 1922 the insects were found about 10 miles farther up the Sulfur Springs Valley and attacking all kinds of curcubits it, including the native gourd, *Apodanthera undulata*. In 1923 the range had extended about five miles farther. Notes prepared for publication in 1922 were held up pending the identification of the species. This has not yet been done to the satisfaction of the writer. The entomologists at Phoenix stoutly maintain that the insect is nothing more than a variation of the bean beetle. When beans and cucurbits are found growing immediately adjacent, as at all other times, excepting the cases in which the bean beetle exhausts its favorite food plant, the forms on the two crops are distinctly different. The fourteen spotted form has been found invariably on the gourds. As a rule it is larger than the bean beetle. During the summer of 1924 it is hoped that an opportunity will be afforded the writer to observe this partially dressed "bean beetle" in captivity sufficiently long to determine the fixity of the form and to determine the possibility of crossing with the sixteen spotted type.

WYATT W. JONES

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Proceedings of the Thirty-sixth Annual Meeting of the American Association of Economic Entomologists (*Continued*)

Morning Session, Tuesday, January 1, 1924

The meeting was called to order at 10 a. m.

PRESIDENT A. G. RUGGLES: The first papers on the program this morning will be a symposium on "Methods of Estimating Insect Abundance and Damage."

STATISTICAL METHODS IN ENTOMOLOGY

By J. A. HYSLOP, *Washington, D. C.*

ABSTRACT

Entomological survey work has passed the stage of guessing and the biometric method must now be inaugurated in order that the great mass of data being collected by the increasing number of observers may be interpreted. The immediate problem is to establish a standard set of units in entomological survey work and the second problem is to establish the range and type of insect dispersal.

A year ago, before the collaborators of the Insect Pest Survey and the extension entomologists, I outlined the functions, as I conceived them, of the Survey. I wish here merely to re-state its ultimate objectives;

First, to prepare an atlas of our insect pests, not merely distribution maps, broadly blocking in the extreme distribution records, but a weighted map of each species indicating the optimum zone, range of injurious records, and extreme distribution;

Second, to obtain each year as complete an insect census as possible;

Third, to correlate the above data with known variables, to determine the factors which limit insect dispersal and abundance, and,

Fourth, from these determined correlations to lay the basis for insect forecasting.

The title of the subject chosen for this year's symposium is, in one

sense, fortunate and, in another sense, rather unfortunate. By a broad use of the word "estimating" we have drawn the fire of the statisticians.

In the Survey's work it has become increasingly more evident that the estimates we are receiving from our collaborators lose much of their potential value in that; (a) they are not based upon sufficient nor detailed enough observations and (b) that each reporter is forced to adopt original methods of estimating insect abundance which are usually not comparable with the estimates of other collaborators. I do not wish to be construed as criticizing our collaborators as we have gained much in the past three years of the Survey's work in locating the areas of intense damage of many of our more important insect pests and wish our collaborators to continue to send in miscellaneous observations of insect abundance as there is still much to be done along this most profitable line, and it is probably the only line which we can pursue to advantage with our limited funds and organization, but the ultimate object of the Survey is to use this mass of data in statistical entomology and, in order that it may be used for this purpose, it must meet with the requirements of the statistician, that is, the requirements of mathematical common sense.

I wish to digress here for a moment to impress upon you the ridiculousness in carrying out figures in reports which are arrived at by statistical methods to such a point that they indicate the most accurate mathematical precision. An amusing report was recently brought to my attention which eminated from a fish hatchery and gave, after a wordy report, figures similar to the following: indicating that during the past year 13,280,642 fish and fish eggs had been distributed by the hatchery.

We do not wish to perpetuate the old inductive method whereby an entomologist, by virtue of his experience and familiarity with the subject, would go into the field and estimate (in the sense of guess) at the percent of damage being done or the relative number of insects present. These guesses were more or less accurate, usually less, but, even if we disregard the personal equation, they are absolutely useless for statistical work. Even a so-called statistical survey on insect abundance, arrived at by actual count of presumed sample units, is often based on counting and calculating processes and samples which introduce not only a possible error but a probable error, which is greater than the results obtained.

One of the most important things that we will have to pre-determine in this work is a definite standard of accuracy and every record should be brought up to this standard. The data which we use must be based

A month after the treatment counts were again made of dead and live scale from both treated and check trees.

After the first brood of young had settled, counts were made to determine the number of newly settled scales on a given length of at least ten representative twigs of new wood from each tree or from an equal number of leaves.

At harvest, the fruit, in the case of apple, was examined and graded on the basis of scale infestation, using the terms very slight, slight, moderate, heavy, and heavy encrusted, or using an arbitrary scale running from one to ten to determine the degree of infestation.

In the fall after the majority of leaves were off, the trees were examined to determine the degree of infestation, applying the method used previous to the treatment, for comparison with the original degree of infestation.

Inasmuch as the personal element is certain to enter into counts and estimations, all counts and estimations used in a comparsion should be made by the same person, and it is often desirable to have separate sets of counts made by another individual to check upon.

METHODS OF ESTIMATING BOLL WEEVIL LOSSES

By W. D. Hunter, *Bureau of Entomology*

Abstract

Probably more attempts have been made to estimate boll weevil, *Anthonomus grandis* Boh., losses accurately than have been made in the case of any other insect. Such estimates have been made by entomologists, crop reporters and commercial organizations. By far the most accurate estimates have been found to be those made by entomologists. A very accurate estimate can be made by comparing production on plots treated with calcium arsenate and on plots untreated. The difference in production is a precise measure of the amount of damage caused by the weevil. The usefulness of this method could be greatly increased by test plats provided by state entomologists in different parts of their states. Estimates made by crop reporters have been found to show a strong trend toward exaggeration. Those made by commercial organizations are frequently colored by market conditions.

The American cotton crop has probably incited more statistical inquiry than any other crop produced in this country. It is not surprising that a great deal of the available statistical talent has directed its energies towards estimating the damage done by the boll weevil.

In general the methods of estimating boll weevil losses may be thrown into three groups, namely, those followed by entomologists, those by crop reporters and those by commercial organizations.

The methods followed by entomologists may be discussed in two

classes, one dealing with regional losses in a series of years and the other with losses accruing in a single district in a single season.

In determining regional losses the only method followed has been to compare the production per acre before and after the advent of the weevil. This is by no means a precise method. One reason is that there are frequently trends towards reduction in production due to the depletion of the soil and to other factors, which began to appear long before the coming of the weevil. It is frequently impossible to differentiate between the effect of these trends and what the weevil has done. Another difficulty is that production per acre in the country is not determined accurately except in the census years and intermediate years are only estimated.

In determining the loss in any one season an effort has been made by entomologists to ascertain the amount by finding the percentage of infested squares and bolls throughout the season. This quantity can be obtained readily. With its use and a proper allowance for natural shedding a fairly accurate basis is secured. The practical difficulty is to obtain sufficiently extensive series of field examinations. Up to recent times this has been the most accurate method available. Now, however, a different system can be followed and is being used to a considerable extent. This makes use of the fact that when properly applied calcium arsenate practically eliminates the factor of weevil damage in a field. The difference, therefore, between the production on treated plots and on check areas gives an accurate reading of the results of the work of the weevil. The degree of accuracy attained depends upon the proper selection of control areas (not always an easy matter) and the attacks of such insects as plant lice, which, however, generally affect controls and treated areas to about the same extent. The Bureau of Entomology has had numerous experimental plantings for several years in many states. They were located with reference to regional differences. The results obtained give by far the most accurate effort of estimating damage which has ever been devised. The precision and usefulness of this system could be greatly increased by the cooperation of the states in placing treated and check plots wherever needed.

The method of estimating insect losses through the Crop Reporting Service is well known. Trained correspondents of several classes report their opinions as to the amount of weevil injury based on their own observations and information obtained from local farmers. The result is merely a crystallization of the conception of the farmers as to what the losses may have been. Its greatest weakness is in the natural

tendency to attribute to one conspicuous factor like the boll weevil the damage actually attributable to a number of causes. The trend in these estimates is undoubtedly towards exaggeration, as has been shown by many comparisons between Crop Reporting Service estimates and those made by entomologists which have been made by students in the Department of Agriculture.

The Department is now conducting a large experiment in increasing the accuracy of crop correspondents estimates of weevil losses. Experts of the Bureau of Entomology and Plant Industry have drawn up a questionnaire which has been sent to about 150,000 farmers throughout the South. This questionnaire will make it possible to correlate reductions in the crop with many factors entering into its production, including varieties, time of planting, spacing and many others. It will also furnish a basis for correlating different methods of weevil control and production. According to the statisticians it will yield the largest number of variables which have ever been considered in any statistical inquiry. The work of tabulating and correlating on special machines will occupy the time of several men for a number of months. The outcome of this inquiry can not be foretold, but it probably will yield very favorable results.

The commercial estimates of weevil losses in many cases are made through the reports of local correspondents. In many cases the number of correspondents is small and it is suspected that some of the estimates are merely evolved in offices in New York, New Orleans or other places. While many of the estimates are made with care and good intent, there is always the possibility that any commercial report may be colored by the bull or bear interest of the concern which makes it.

ESTIMATING THE ABUNDANCE OF, AND DAMAGE DONE BY GRASSHOPPERS

By Stewart Lockwood, *In charge Billings Laboratory, Bureau of Entomology*

Abstract

Because of extreme activity the numbers of grasshoppers, Acrididae, are hard to estimate. By aid of a field glass the observer can stand at some distance and count those in a given unit. Many units of ground should be so counted in a field before an estimate of the grasshoppers can be made.

A knowledge of the egg laying habits is necessary before an estimate of the number of eggs in a locality can be made.

Estimating the per cent of damage in a particular field is done by comparison of the amount of damaged seed in several small units with the undamaged seed.

When making up a statement of the damage done by grasshoppers over a wide area, the entomologist should, when possible, compare the yield of damaged sections with the yield of localities where there were no grasshoppers but which had other limiting factors equal. A comparison of the yield during the grasshopper infestation with the yield in the same localities but in years when there were few, if any, grasshoppers can be made but before the entomologist can estimate the damage done by grasshoppers, he must know the action, during the years under comparison, of other limiting factors such as rainfall, temperature, sunshine, winds, and crop diseases.

Estimating the numbers of an insect which during the daylight is almost continually on the move and that becomes disturbed at the first unusual movement of the observer is sometimes an exasperating proposition. In 1920 C. L. Corkins, investigating *Melanoplus atlanis* (Riley), by aeroplane in North Dakota, found the bulk of a swarm flying between five and 600 feet and observed a few stragglers at an altitude of 1,650 feet above ground.

In our work with grasshoppers we often have to estimate the number of eggs in a locality and, later, do the same with both nymphs and adults.

In investigating the number of eggs with the thought of prediction of the character of damage in the future, a knowledge of the egg-laying habits of the economic species common to the particular section is, of course, necessary. A wide variance in the choice of place for oviposition occurs with different species in the hard spring wheat area, and to a lesser degree this choice differs with the same species in different localities. The prevailing methods of tillage function importantly in this matter. In the Northern Great Plains, *Melanoplus bivittatus* (Say), *Melanoplus differentialis* (Thomas), *Camnula pellucida* (Scudder), and *Dissosteira carolina* (Linnaeus) commonly deposit their eggs in beds having rather distinct borders. The eggs of *Melanoplus atlanis* (Riley) are not as commonly placed in beds but more often are scattered over wider areas. Consequently, when making estimates of the possibility of outbreaks of the first four species previously mentioned, the number and size of the egg beds is taken into consideration but with *Melanoplus atlanis* (Riley), the number of pods located is the determining factor. In a section where the ground is rocky yet covered with grass or other vegetation, the eggs of *Melanoplus bivittatus* (Say) commonly are found at the base of half-buried rocks, as a rule more numerously on the side that receives the direct sunlight between noon and four o'clock in the afternoon. In some sections the eggs of this species occur in the crowns of alfalfa but in the alfalfa regions of western Nebraska and eastern Wyoming, these eggs are more often found close to the roots of grass

that is growing in the alfalfa. This also applies to *Melanoplus differentialis* (Thomas). Fence rows, ditch banks, closed drains, and roadsides having a southern exposure and stack yards are also places where these two species commonly oviposit. In the irrigated alfalfa fields of Wyoming, *Camnula pellucida* (Scudder) chooses high, dry knolls as the best places for its eggs. Further north this species prefers to deposit its eggs directly into the roots of grass. In the hard spring wheat section, the small grains grown on rather light sandy soil often are more severely damaged by *Melanoplus atlanis* (Riley) in the early part of the year than nearby crops grown in heavier ground. In such sandy sections the eggs of this species are commonly found at the bases of old grain stubble. The strips of sod between the fields and between the roadsides and fields and headlands are the places where *atlansis* eggs can be expected. We have had better success in locating these eggs under mats of dead vegetation, such as a pile of Russian thistles or tumbling mustard lodged against a fence, than in places where there was no such covering. In the open prairie this species of grasshopper is inclined to deposit its eggs on sandy or rocky knolls or ridges having more or less growing vegetation. The number of egg parasites and predators in these localities is also a factor to be reckoned with.

In estimating the number of grasshoppers in a field, several methods may be used. Where the grasshoppers are dense and moving in one direction an imaginary line may be drawn across the path of movement and measured in feet, yards or rods, and after sufficient time has elapsed for them to have gone forward across the line a foot, a yard or a rod, the number having crossed this line within the measured unit can be considered as those contained in a square foot, yard or rod. This process should be repeated in several places as well as measurements made of the occupied area before an accurate estimate of the numbers of grasshoppers in such a band can be made. It has been our experience in the Northern Great Plains that the nymphs of *Camnula pellucida* (Scudder), assume the marching habit far oftener than the other economic species. We have not found such marching bands of grasshoppers very often.

When making a quick examination of a field where no experiment is to be carried on but where an estimate of the relative number of grasshoppers, in comparison with other fields, is needed the worker soon learns to make fairly accurate comparisons by walking thru fields and making observations as he goes. This often is done by men in charge of county or township campaigns or by their scouts and tends to de-

termine the amount of materials which the grower will need to poison the grasshoppers.

Attempts have been made to estimate the number of grasshoppers by collectors who used nets of the same size and made a certain number of sweepings in a given number of steps but we have discarded this method because it was felt that a compilation of the reports of several workers using this method was not accurate enough for scientific purposes. Sweepings made at different times of the day, under varying climatic conditions, in different crops, together with the varying speed of the operators upset the uniformity of such reports.

While not essential it is highly desirous that sufficient plots of crop be used in carrying out a control experiment that have equal or nearly equal degrees of infestation. When the grasshoppers are adult the person about to engage in such an experiment may approach his plots in the early morning as soon as it is light enough to see distinctly and before the grasshoppers move readily. By observing caution the grasshoppers that are resting inside of a given unit, say a square yard, can be counted. Naturally, counts in such plots must be made in several places. The locations where counts are made may be chosen in much the same manner as that adopted by an adjuster in determining the amount of hail damage to a crop. When the grasshoppers are still quite small, such a method does not give as accurate a count as when larger. Young grasshoppers are inclined to shelter themselves under close-growing foliage and in cracks and rubbish during the nights and colder parts of the first daylight hours. Under such conditions the number of grasshoppers in a predetermined unit can be counted with the aid of a low-powered field glass, by slowly approaching near the places chosen at random and remaining there quiet long enough to permit the few grasshoppers that have fled to be replaced. It is easier to do this during the extreme heat of the day when they are sluggish. At this time the grasshoppers are resting in the foliage, on the tops of clods of earth and in spots bare of vegetation. This method may also be used with adults.

While the damage that grasshoppers do to individual plants is plainly discernible, the amount of damage to a crop is not always readily estimated. It sometimes happens that in the spring of the year small grain is ravaged by young grasshoppers coming in from adjacent egg beds. They eat as fast as they travel leaving borders of bare soil. If these are killed before more damage is done, the percentage of damage can readily be calculated. It is not often that a second growth comes from

the roots left in the ground but this occasionally occurs. Where the grasshoppers are uniformly numerous in a growing field the damage they do is not so easily seen unless it be of a high percentage. Well-developed growing grain may be severely checked, yet mature a very good crop later on if the grasshoppers are killed. The yield of hay taken from an infested field when compared with the production during years when there were no grasshoppers, other factors being equal, presents a definite idea of the damage done to forage crops. In the case of either cereal or field crops, grown for seed, and which are nearing maturity before grasshoppers occur in the field, the percentage of damage done may be estimated by examining different parts of the field and by counting the chewed kernels, dropped heads or seed balls in a predetermined unit and comparing this count with the seed in undamaged areas. This is the method that adjusters commonly use to ascertain the damage to a crop by hail.

In making up a statement of grasshopper damage for a state or even a county, the aid of several people is needed unless the entomologist has spent the entire time in a district where the estimate is made, and, even then, a close knowledge of past crop values is needed. We cannot conceive that the observations of a single person could be sufficiently accurate for him to properly estimate the damage done by grasshoppers in an entire state; at least, in a state so large as those in the northern plains. When working with such a problem, we ask and receive aid from other agricultural workers. County agricultural agents furnish information as to the acreage infested and the intensity of the infestation. Such information often is furnished, plotted on county maps and shaded to represent the degree of infestation. They also submit their own estimates of damage done. This is compared with information obtained from other sources.

Limiting factors other than grasshoppers must be taken into consideration. From plant pathologists and agronomists the general condition of the crop and the prevalence of plant diseases is obtained. From the reports of climatological observers we obtain the departure from normal of precipitation, temperature, wind, and number of days of sunshine. From the reports of crop statisticians the production of the crops the grasshoppers have damaged is obtained and this is compared with the normal production and the production during years when grasshoppers were not prevalent. When possible the production in damaged sections is compared with that of adjacent districts having other factors equal. A compilation of reports received from those whose crops have

been damaged is not in itself an accurate estimate but we believe such reports have sufficient merit to warrant their being requested, especially where the entomologist has a large list of active farmer cooperators. A questionnaire should be furnished which can be filled out in short concise statements.

Having in hand a knowledge of the infested areas, the degree of infestation, the production of such areas during immune periods, and the production during infestation and the action of other limiting factors, we believe that the entomologist may compile a statement which, after comparison with the individual estimates of county agents and farmer cooperators, will be a close estimate of the damage done. We believe that such an estimate should present the damage done in terms of percentage of crop loss rather than monetary loss.

THE APPLICATION OF STATISTICAL METHODS TO THE DETERMINATION OF ABUNDANCE OF AND DAMAGE BY HESSIAN FLY[1]

By W. H. Larrimer, *Entomologist, U. S. Bureau of Entomology, West Lafayette, Indiana*

Abstract

The discussion of the determination of abundance of Hessian fly, *Phytophaga destructor* Say, is confined to methods used at the U. S. Entomological Field Station at West Lafayette, Indiana. Percentage and intensity of infestation are determined in the fall as an indication of the magnitude of the menace to fall sown wheat and the success of the advised control measures. A similar determination is made in the late spring to indicate the probable status of the Hessian fly menace to wheat sown the following fall.

As yet no methods have been found acceptable for the determination either before or after harvest of the amount of damage done by Hessian fly.

The use of so-called statistics in studies of this nature as well as in other entomological investigations without appropriate consideration of the theory of probability is questioned.

Most of the pioneer entomologists of this country must have felt the need of figures for the basis of opinions and consequently devised some sort of statistical methods for use in connection with their study of Hessian fly. Practically every economic entomologist since has contrived or adopted some scheme of measuring or estimating abundance of and damage by this most important insect pest of wheat. It is intended to confine the present discussion of methods of determination of abundance to those now used in making such determinations at the

[1]*Phytophaga destructor* Say: family Cecidomyidae: order Diptera.

U. S. Entomological Field Station at West Lafayette, Indiana and to express an opinion as to the general unreliability of methods of determination of amount of damage.

ABUNDANCE

The abundance of Hesssian fly is determined twice each year, once in the fall and again late in the spring, each time for a different purpose. Both determinations are made by the same method and at the time when most of the fly forms of the respective generations are in the flaxseed stage.

Regular date of sowing experiments distributed over the area under observation but entirely at random as far as Hessian fly infestation is concerned, serve as the source of material. These experiments consist of five to seven sowings of approximately one-tenth acre each, made at intervals of three to five days before and after a date previously considered as the best sowing date. A sample of wheat plants is taken from each sowing by a method which is an adjustment of the various theoretical and practical demands. In this case it consists of approximately one hundred plants taken in five random lots of approximately twenty plants or culms each. The samples thus obtained are removed to the laboratory where they are carefully examined and the following information is recorded; number and respective date of sowings; number of plants and number of culms examined; percent of plants and percent of culms infested; for the fly forms that are larvae, the size, total number and maximum and average number per infested culm; and for the fly forms that are puparia, the total number and the maximum and average number per infested culm.

Flaxseeds obtained from the fall examination are caged in 9x36mm. glass vials plugged with cotton and inserted in holes bored in plaster slabs to rear possible parasites for specific determination. No attempt is made to determine the percentage of parasitism in the fall because the presence or absence of parasites at this time does not directly affect any possible artifical control measures as yet developed and does not assist in the formulation of a program of action to meet a possible spring menace of Hessian fly.

The principal results therefore of the fall examination are the determination for each experiment of the percentage and intensity of infestation of the samples from the sowings made on different dates and the determination and distribution of the parasites obtained. The

percentage and intensity of infestation are used as an indication of the success or failure of the advised seeding dates and of the magnitude of the menace that existed to fall sown wheat.

Though only a matter of opinion, the advised seeding dates are considered good when the maximum infestation in any sample taken from sowings on or after these dates is less than ten percent of the infestation of any sample taken from sowings made before these advised dates. Intensity is the term used to represent the average number of fly forms per infested culm or plant.

Flaxseeds from the late spring examination are disposed of in the same manner as those obtained in the fall except that fifty, to one hundred are dissected to determine the percentage of parasitism.

The principal results of the late spring examination are the determination for each experiment of the percentage and intensity of infestation of the samples taken from all the sowings and the percentage of parasitism, determination and distribution of parasites of the flaxseeds thus obtained. This information is then used to indicate the probable status of the Hessian fly menace to fall sown wheat and thus is the basis for an opinion as to how much emphasis should be given to secure the observance of advised dates of seeding and other control measures the following fall. In addition to the information previously discussed the figures obtained serve as an indication of variations in the abundance of Hessian fly in different localities for the same year and in the same locality from year to year.

Damage

Considerable thought has been given to the possibility of devising some scheme of correlation of fall and spring infestation of Hessian fly with the amount of resultant damage as indicated by final yield. It seems quite obvious that damage and sometimes severe loss can be directly associated with either fall or spring infestation. In the case of abandonment of entire fields which sometimes occurs due to extremely heavy and timely infestation, no index of injury is needed to predict the extent of reduction in yield at harvest time. Some damage must be caused by less severe but varying degrees of infestation but because of inconstant variation of other contributing factors, no satisfactory scheme has yet been developed by which the effect on final yield may be predicted with even a fair degree of dependability by a known percentage of infestation in fall or spring.

Some effort has also been made to develop a method to be used after harvest to estimate with some fair degree of reliability the total amount of damage that can be charged up to Hessian fly. For instance, the estimated number of acres of wheat sown in the state of Indiana in the fall of 1919 was 1,960,000. Of this amount 225,000 acres were estimated to have been abandoned in the spring of 1920 because of infestation by Hessian fly the previous fall. From the acreage left standing, the yield was estimated at 7,280,000 bushels less than would have been produced by a ten year average yield. Considering this deficiency due to Hessian fly and computing the probable yield of the abandoned acreage on the basis of the ten year average yield, a total loss of 11,260,000 bushels could be estimated.

As a contrast to this scheme of estimation there is the well authenticated case of a similar estimate being made in a mid-western state where the task was assigned to a farm director and two agronomists. Each of the three made up his mind off hand and independently. The average thus obtained was considered too large and after considerable discussion it was cut exactly in half. This final result actually appears in the publications of that state as an unqualified statement of a definite amount of damage caused by Hessian fly.

This second case need not be further considered except to express the opinion that such estimates are far too frequently made. Without going into details in discussing the first case, the many non-compensating and irregular factors other than Hessian fly infestation that enter into the final yield of wheat should be considered. The effect of variation of soil and seasonal conditions is exceedingly important. Joint worm is some years worse in early and other years worse in late sown wheat. The greater wheat stem maggot is evaded by delayed sowing much the same as Hessian fly. Leaf rust is usually worse in the fall on early sown wheat and in spring on the later sowings, but this factor is far from constant from year to year. The observance of advised seeding dates varies in different parts of the country and in the same section from year to year. All of these interrelated factors, together with many more which could be mentioned, certainly emphasize the extent of the unreliability of any such estimates of the amount of damage by Hessian fly. Have not such estimates in the past been largely figures based originally on an opinion rather than an opinion based on figures? It might be pertinent to inquire as to the fundamental purpose which it is intended that such estimates should serve and whether or not this

purpose might not be defeated or perhaps served just as well if the nature of their dependability was recognized, admitted and furnished along with the figures.

This brings up an old subject about which many books have been written and in which renewed interest has been taken in various fields of research within the last few years. It is desired to call attention to the disregard, especially by Entomologists, of the Theory of Probability, which in all available texts examined has been treated as indispensable to the application of Statistical Methods.

Theory of Probability

While, as has been stated, the earliest workers on Hessian fly employed some sort of Statistical Methods in estimating its abundance and damage, there does not seem to be a single reference of an attempt to apply the Theory of Probability to determine the reliability of such methods. As a matter of history, the Theory of Probability is older than that of Statistics, and has now been developed to the place where its application lends a powerful tool to investigations in many lines of research. By the application of one of the principles of this theory the measure of unreliability of the determination of any value is given by the probable error of the determination. This is usually expressed in the form of a pair of values, one above and the other below the value determined, the chances being even that the true value lies between these limits.

By the application of the Theory of Probability to methods of determination of the abundance of and damage by Hessian fly, it seems quite likely that data from which heretofore definite conclusions have been drawn really should have been taken merely as indications more or less reliable as the particular case may have justified. Often percentages of infestation and parasitism have been recorded without giving the probable error or any description of the method of determination. All too frequently such percentages are expressed in fractions, sometimes even hundredths of one percent, entirely disregarding any error of method which doubtless exists to the extent of several percent. Such practices are often not only the basis of unfounded conclusions, conflicting recommendations and hair splitting estimates, but are in themselves misleading in that they assume a non-existent refinement of method.

Would it be presumptuous to suggest that much real progress could be accomplished by the careful consideration of the application of the Theory of Probability not only to future work along lines as herein discussed, but to many other entomological problems as well.

MR. C. L. MARLATT: The symposium which we have listened to has been one of much interest and profit. The different speakers in the discussion of methods and their values as seemed to them pertinent have covered the field so well that there is little left to be said on the subject assigned to me. I think if we properly digest what has been said this morning it will be possible for any of us to choose and follow a method or methods which will meet our needs and if we do so we will come pretty near achieving as good statistical work on insect damage as is now possible. Any phase of the subject that I might now take up would be more or less in repetition of what has already been said by one or more of the speakers. A few general considerations may nevertheless be opportune.

The discussions have ranged from the practical or more commonplace field methods of estimate to strictly technical and intensive methods and both systems undoubtedly have their place. The very commendable tendency of the modern to increased technical accuracy should not, however, lead us to lose sight of the value of the older and simpler methods of estimating insect losses. I am willing to wager that an expert who has been working for several years on the San Jose scale or codling moth subjects, for example—and I say an expert as contrasted with someone inexperienced—can make, after a fairly thorough survey of the orchard concerned, a general estimate that will be about right as to infestation and damage and that sort of estimating undoubtedly will continue to be the one generally followed.

I am inclined to believe the personal element has more to do with the accuracy of results than the method. If you run over in your minds the estimates which have been made and published in past years, I think it is clear that such personal element has been the dominating factor and this idea has been brought out by many of the speakers.

In the matter of all such estimates as we are now considering it is well to remember that the world has become very doubtful of or at least has come to look with some question on statistics and statisticians, and we in the Federal Department of Agriculture do not have to go very far

afield to find that out. Perhaps no office in the Department has been in hot water so often, rightly or wrongly, as our statistical office. We, as insect-loss statisticians, may get too close a view of our subject and lose the necessary contacts or perspectives. It is important to remember that we are not alone in the field of estimating plant pest damage. There are the phytopathologists, nematologists, ornithologists, and mammalogists, to say nothing of the ecologists and other ologists, and all of these must have their rake -off! In our estimates we must take account of all these factors and leave a little over for the other fellows, and a little over after all that for the farmer! He must have something!

In general in our estimates of crop damage the crop produced is the last word on the subject. If such crop of wheat, for example, is only 5 bushels to the acre under severe Hessian fly attack—other conditions being about normal—one can fairly safely charge the reduction from a normal of say 15 bushels to the acre to the fly. The crop itself, in other words, tells the story. That all the factors concerned in possible crop production must be taken into account has been stressed by most of the speakers, but I think none of them has indicated that the farmer has some rights in the matter, and that you must leave something for him. I can illustrate by the story of a young lawyer who had won his first case and had secured quite a large sum for his client. He was disturbed about what fee to charge and went to an old seasoned lawyer and asked him if he thought 10 per cent would be about right. The answer was: "I think I would leave your client a little more than 10% if I were you."

On the subject of the detail necessary in estimating losses I think there is some tendency to go into too much minutiae. Such course may lead, as already indicated, to a narrowing of the viewpoint and a failure to properly gage the general damage for the region or district concerned. A great deal of insect damage is spotted and there is a human tendency which it is almost impossible to overcome and regulate—to go to the spot where the damage is worst. This danger adheres in the selection of the field, orchard or tree to be the basis of the estimate and this is one of the difficulties which we have all got to face and keep in mind. One may easily go to the extreme of detail of observation, countings and tabulations, involving weeks and months of hard work and accumulate altogether too much of statistics and then naturally you want to publish it and that is the worst of it! I believe in accuracy but please file most of the working details and tables in your offices. If anyone questions your

conclusions, these details will be available to substantiate your work. Do not insist on their being published. I am one of the editors of a research magazine—that of the Department of Agriculture—and I know what comes over my desk and the burden of detail often gives me great pain.

In conclusion, and referring again to the widespread doubt and suspicion which attaches to statistics and statisticians, I will venture another old story, namely, the definition of liars: "Liars, damn liars, and statisticians."

Mr. H. A. Gossard: I noted in my memorandum, as the speakers were going along, some of the things Dr. Marlatt brought out, and I am glad he brought those things out so distinctly. I will not now need to say very much about them, but he is the last speaker on the floor, and, of course, he is leaving the last impression. I hardly agree with him to the full degree of his seeming condemnation or perhaps I would better say the limitations he is disposed to endorse; but I heartily agree with him about the personal element that so vitally affects all conclusions and forecasts. I recognize in this method of taking statistics one of the methods by which we may hope to make progress. It is worth trying. Don't trust it too far, but it is one of the most promising programs we have for making real progress.

I thoroughly agree with Dr. Marlatt that there is very much in the personal element, and while I won't say there is such a thing as an instinctive Entomologist, who knows and acts by instinct, there is sometimes something that is quite akin to it. Yet, I usually find that the man who is operating apparently by instinct, really has in the back of his head somewhere, some statistical data, or some experience which is the basis for his judgment. Now, for instance, when we come to the matter of entomological forecasting—we have done considerable forecasting at one time or another in our state in regard to the coming of Hessian flies; we add something to the method that Mr. Larrimer has presented—in fact, we have all of his data placed at our disposal. But we have added to that for the past several years, a wheat survey made just before the harvest time, by which we take samples from several fields in each county and make an accurate count of the degree of infestation. But we don't wholly trust that count. We don't pretend that the figures we get are absolutely accurate or representative, but we know they are approximately accurate, within 10 or 15 per cent. anyway, if the infestation is high, and much closer if the infestation is low. We know

beyond guessing that if there is a wide outbreak of Hessian flies impending, we will be able to discove r it, and it will not take us by surprise.

Then, having determined this fact, we further proceed to gather enough data—trustworthy data—so that we can say just when the people in our state should sow; we determine this by another plan. We check several methods against each other. We prepare an emergence cage in which the adult flies can come forth, trying to make the conditions in the cage as nearly like those outside as possible. We keep a daily record of the number of flies appearing in the cage. We also have a certain number of marked wheat plants on which we keep the record of the number of eggs that are laid each day, and we scrape those eggs off after each examination so as to leave a new, clean slate to receive the eggs for the next day. We keep the records throughout the egg-laying period, so we have the date of maximum egg-laying. We have checking against these two devices, some wire screens set up at right angles to each other to catch the wind from all four directions equally well, and the wires coated with Tanglefoot; and we take the number of flies that are caught daily in that.

We find these devices check against each other splendidly. There is only a difference of a few hours we get as the date of maximum general emergence as determined by these three checks against each other, and in that way we determine to a considerable extent—in fact, we depend quite largely on this combination method to say when the time for our wheat growers to sow has come.

But we do not trust this conclusion absolutely. Suppose we were to find from the emergence records, that we were getting several days beyond the time which average and long experience, and such records as Mr. Larrimer has accumulated, would show to be best. That is one of the things that has been right in the back of our heads, as something we might be obliged to consider any year. If we were to find the maximum emergence crawling up to a very, very late date, the question would come up whether we could wait any longer; it might be two or three days before we would have the maximum record, but just upon the general principle that we would be apt to run into more danger from winter killing than from Hessian fly, we would probably give the signal to sow in such a case. We have not as yet been compelled to do that, but it has been in our minds a number of times that we might be obliged to choose this course.

I recall one or two instances of estimating Hessian fly damage that seemed very accurate to us at the time we made the calculations, and yet

I wouldn't trust the estimates today at all. I think, if any of you remember our old Hessian Fly Bulletin, No. 177, you will probably recall the picture of two jars in which we showed a number of grains of wheat threshed out from a certain number of straws, and in another jar was the yield from an equal number of straws which were not infested with Hessian flies. We assumed that the difference between those two measures indicated the loss.

I don't think so at all today, because I have learned that the Hessian fly in the spring of the year seeks plants of a certain stage of development and size, and that they seek those plants which are backward and weak, and I am satisfied that the difference as shown between those pictured yields is altogether too great. In other words, the figures "lie." So such things are not always altogether reliable.

Another point was brought out which I also wish to emphasize. We should be very careful to distinguish between actual loss and monetary loss. The damage is usually stated in terms of the consumer's dollar. As a matter of fact, the producer would take an entirely different view of the subject, and his monetary loss is entirely different. In many cases Hessian fly damage is of tremendous importance and a great loss to our population as a whole and to the consuming public, yet it may have been an actual advantage to the farmer and producer because the insect limited their surplus and prevented a depression of prices.

When I read that in Ohio, in the year 1900, there was a monetary damage of $15,000,000 I don't know what the damage was in bushels, unless I know the average price of wheat for that year. If it had been stated in bushels in the first place, I wouldn't be obliged to go back and find out what the price was.

And the same thing is true throughout. I am heartily in sympathy with the plans of Mr. Hyslop. I believe there is a future for forecasting. I am wondering whether or not a little more determined cooperation on the part of the collaborators would not materially aid the pest survey. These collaborators are very busy. We have our own problems in our own states, and we can't add on several additional projects, but the survey is a matter of such promise and of such great importance that it would seem to me we might take on, each of us, some one particular problem if that were assigned to us, and we would then see what we could do with it as part of the plan that Mr. Hyslop has proposed.

Mr. J. A. Hyslop: I certainly wish to thank Professor Gossard for

his suggestion of help from our collaborators. I may propose this to several of them. I believe, however, in this symposium, the main feature brought out has been the fact that we *do need a unit standard* in *measuring insect* abundance, not necessarily to be applied to highly mathematical statistical tests, but if we have some standard unit and one man reports, we will know what he means.

I had two most amusing reports coming respectively from a northern and a southern state in 1921. The northern state, one of the lake states, reported that the corn earworm was devastating the corn crop. The southern report stated that the corn earworm was moderately abundant. I happened to know the conditions in the two states, so I sent the same letter to each of the two reporters and asked them how many ears in a dozen were badly infested, and how much of the corn was eaten from each ear. The report of the northrn state came back that there were one or two ears in a dozen that were worm-eaten at the tip. From the southern state the reply came back: "about every ear and about half the corn on each ear."

We really need some measuring stick by which a man can publish information about an insect, and another man can use that information in comparing the results obtained, particularly in insecticide work.

Mr. E. P. Felt: Wouldn't it be possible to have as an outcome of this symposium, a committee to attempt to standardize in a general way, methods of estimating. We cannot compel an individual to use a certain standard, but if a committee could formulate the most approved methods for the calculation of injury in relation to different insects under various conditions, and bring a little pressure for the adoption of a standard, not necessarily too complex, but simple and basic, I believe it would be a long step forward in solving a rather vexatious problem such as the insect survey has to meet now.

I would move that the Chair appoint such a committee. (It was so voted).

Mr. R. L. Webster: It seems to me that if we are going to make estimates of crop damage from insects, it is necessary that we determine what is a full crop. In some of the data published by the Department of Agriculture the best crop that has been produced in a locality, such as in one county, for instance is considered as a full crop.

It seems to me this is wrong. I cannot imagine conditions that are so favorable that there is no loss by any reason whatever, either from insects or other factors, in any particular area. I think we should con-

sider as a full crop, a figure considerably higher than the highest known crop in any one locality.

MR. W. P. FLINT: Regarding the figures Mr. Webster gave yesterday—it so happens that the man in charge of gathering the agricultural statistics in Illinois is quite interested in insects, and he, at my suggestion, sent out a number of questions to the 1500 crop reporters in the State regarding the damage caused by insects. Last year he sent out a question on chinch-bug damage. While there were some cases of over-estimating and under-estimating in individual counties, the average of these reports gave an 8% loss of the corn crop of the State which was caused by chinch-bug in 1922, and which so far as we can tell was not very far wrong.

I wonder if, in some of the other states, it would not be possible to get these questions included so that Entomologists could get some data from the crop reporters.

MR. W. E. HINDS: Mr. Chairman, I think there is something we entomologists can do in the way of educating statisticians, and getting them to take care of some of these inquiries in a more definite way than they have been accustomed to do in the past.

A number of years ago in Alabama we made decided progress by getting the statisticians to gather data on the yield of lint cotton per acre for each county through the State. That has helped us decidedly, and has given us a means of gauging boll weevil damage from year to year in a degree that wouldn't be possible otherwise.

MR. L. O. HOWARD: Whatever we decide about the damage done by insects and the amount that is saved through our labors, people will hardly believe us. Let me illustrate. A good many years ago Congress, in order to make committee places for all of its members, established a series of committees on expenditures in the different departments of the government—one for the Treasury Department, another for the Interior Department, and so on, including one for the Department of Agriculture. For years little or nothing was done by most of these committees; but an energetic new man was finally appointed chairman of the committee on expenditures in the Department of Agriculture, and he asked the Secretary, "How much is your Department saving the government?" The Secretary passed the question on to the bureau chiefs. I asked Doctor Marlatt, Doctor Quaintance and the other chiefs of sections in the Bureau of Entomology to give me their estimates as to the saving in their particular branches. When I

received their replies they totaled an almost unbelievable sum; so I cut it in half and sent it to the Secretary of Agriculture. The amount was so much larger than that sent in by any other Bureau that the Secretary in turn cut my sum in half. When the report went to the chairman of the committee, he cut in half the amount submitted by the Secretary for the Bureau of Entomology. So the amount finally printed was one-eighth of the original estimate. However, since that date such great work has been done that I am sure that the original estimate that came to me from branch chiefs is by far nearer the truth than the figure published.

PRESIDENT A. G. RUGGLES: The next paper is by E. R. Sasscer and C. A. Weigel.

RECENT DEVELOPMENTS IN GREENHOUSE FUMIGATION WITH HYDROCYANIC-ACID GAS

By E. R. SASSCER, *Collaborator*, and C. A. WEIGEL, *Entomologist, Greenhouse Insects Investigations, Bureau of Entomology, Washington, D. C.*

ABSTRACT

A simple device adapted for simultaneously dropping cyanide into generators was developed and proved practical in commercial greenhouses. Liquid hydrocyanic acid (equivalent to ¾ ounce NaCN per 1,000 cubic feet) was effective against several species of aphids, white fly, and scale insects, but it can not yet be safely recommended for use by the average florist. Further data on plant tolerance of Kentia and Areca palms for HCN fumigation is presented. At low temperature, 1 ounce NaCN per 1,000 cubic feet was not effective against the eggs of *Pseudaonidia duplex* (Ckll.). Miscellaneous data on insect control with HCN is given. Preliminary notes on the use and effectiveness of calcium cyanide indicate that it may become useful as a greenhouse fumigant.

While experimenting with liquid hydrocyanic acid to determine its value for greenhouse fumigation a slight modification of the device employed for liberating the liquid was found to be useful and applicable for fumigating with the pot method as well. The very rapid volatilization of liquid hyrdocyanic acid due to the high temperatures that normally prevail in greenhouses necessitated the development of some method of insuring safe liberation and uniform distribution of the gas. After some preliminary experimentation it was found that the "applicator" as used in California was not so well adapted to greenhouse purposes. The length of the commercial type of houses would necessitate the operator stopping at several points in the house in the application of the liquid and would thus expose him directly to the

poisonous gas. To avoid this risk the following equipment was devised.

Small bottles were spaced equidistant from each other and fastened by means of a small wooden plate to a revolving shaft made of one-half inch gas piping. Pipe extensions of a "T" at one end of the shaft served as a handle for turning over all the bottles at one time. The total amount of liquid hydrocyanic acid required for a given charge was divided among a definite number of bottles which were kept corked. When the gas was to be released the stoppers were removed in succession beginning at the far end and moving toward the door. The bottles were then upset simultaneously by giving the shaft a half turn. The evaporation surface under each bottle was greatly increased by spreading newspapers in a cone-shaped manner over an inverted 10 inch flower pot.

In utilizing the pot method of generating the gas the bottles were omitted and in lieu of these, cups 3 inches high made of ordinary metal spouting were attached to the wooden blocks on the shaft (Fig. 4). After pouring the water and acid into the generators, one of which is placed below each cup, the fumigator distributes the packages of sodium cyanide in the cups and by a turn of the handle the chemical is dumped simultaneously into each generator. In this manner he is not exposed to the gas as may sometimes be the case when the packages are dropped individually into the water and acid.

After trying out this method several times successfully in a small greenhouse the device was installed in a long, single range type approximately 225 feet in length. This improvement worked so satisfactorily that it was deemed desirable to bring it to the attention of entomologists since it overcomes the necessity of being in the house as the chemicals are mixed. Moreover, this feature will undoubtedly stimulate more interest among florists when they become familiar with it in the use of this gas. The fact that one man can safely fumigate a house or possibly a series of open range houses by this method should influence its adoption.

In this connection it seems desirable to refer to Figures 5 and 6 which illustrate a convenient arrangement which recently has been devised for opening the ventilators from the outside of the greenhouse.

Experiments With Liquid Hydrocyanic Acid

During the spring of 1923 investigations involving the use of liquid hydrocyanic acid were undertaken and very detailed and thorough box experiments were first conducted which were later followed by green-

TABLE I. SHOWING RESULTS OF BOX FUMIGATION WITH LIQUID HYDROCYANIC ACID AT RATES EQUIVALENT TO FROM ¾ TO 2½ OUNCES OF SODIUM CYANID PER 1,000 CUBIC FEET OF SPACE WITH AN EXPOSURE OF ONE HOUR

Dosage NaCN in Ounces	°F.	Humidity %	Host	Insect	Interval in days	Condition after fumigation dead	Condition after fumigation alive	Control %
¾	69.8	72	Adiantum	Idiopterus sp.	1	285	0	100
do	do	do	Geranium	Illinoia pelargonii	1	240	0	100
do	do	do	Chrysanthemum*	Macrosiphoniella sanborni	1	1055	2	99.8
do	do	do	Marguerite	Myzus persicae	1	170	1	99.4
do	do	do	Rose	Myzaphis sp.	1	315	0	100
do	do	do	Geranium	Trialeurodes vaporariorum	1	85	0	100
do	do	do	Croton	Pseudococcus citri	3	5	56	8.1
do	do	do	Azalea	Eriococcus azaleae	11	50	51	49.5
do	do	do	Cattleya sp.	Chrysomphalus biformis	10	780	1	99.8
do	do	do	Croton	Coccus elongatus	15	1322	35	97.4
do	84	73	Jerusalem cherry*	Myzus persicae	1	285	5	98.2
do	do	do	Lantana	Orthezia insignis	1	233	0	100
do	do	do	Rose*	Thrips tabaci	1	220	1	99.5
1	69.8	72	Adiantum*	Idiopterus sp.	1	145	0	100
do	do	do	Gernaium	Illinoia pelargonii	1	85	0	100
do	do	do	Marguerite*	Myzus persicae	1	115	4	96.6
do	do	do	Rose*	Myzaphis sp.	3	280	0	100
do	do	do	Geranium	Trialeurodes vaporariorum	1	50	0	100
do	do	do	Croton	Pseudococcus citri	3	2	27	6.9
do	do	do	Azalea	Eriococcus azaleae	11	26	11	70.2
do	do	do	Cattleya sp.	Chrysomphalus biformis	10	1210	0	100
do	do	do	Croton	Coccus elongatus	17	1670	391	81.
do	80.6	64	Lantana	Orthezia insignis	1	430	0	100
do	do	do	Nephrolepsis sp.	Hemichionaspis aspidistrae	7	36	3	92.3
1½	68	67	Kentia sp.	Chrysomphalus aonidum	10	67	0	100
do	do	do	Kentia sp.	Chrysomphalus dictyospermi	10	45	0	100
do	do	do	Nephrolepsis sp.*	Pseudococcus citri	1	1	49	2
2½	78.8	57	Aspidistra	Chrysomphalus aonidum	10	295	2	99.3

*Burning.

house tests to determine what strength of gas a wide range of plants would tolerate.

These tests, the results of which are presented in Table I, were con-

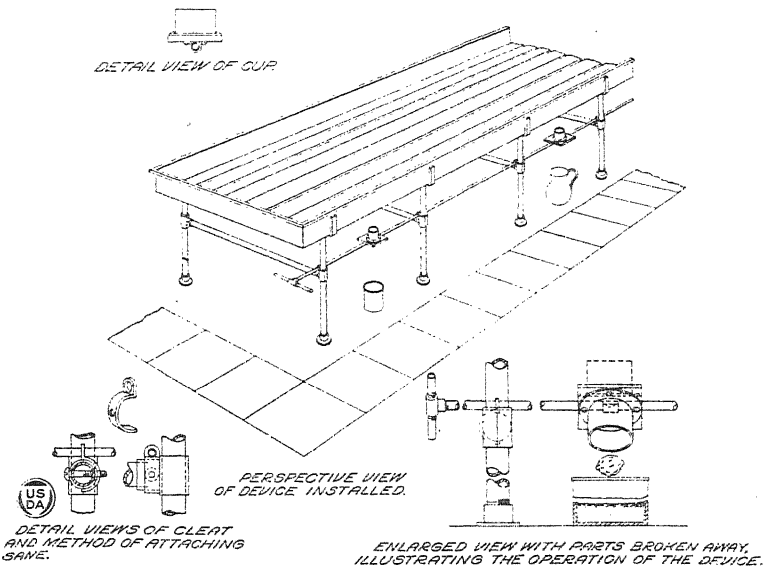


Fig. 4.—Device for dropping cyanide into generators simultaneously.

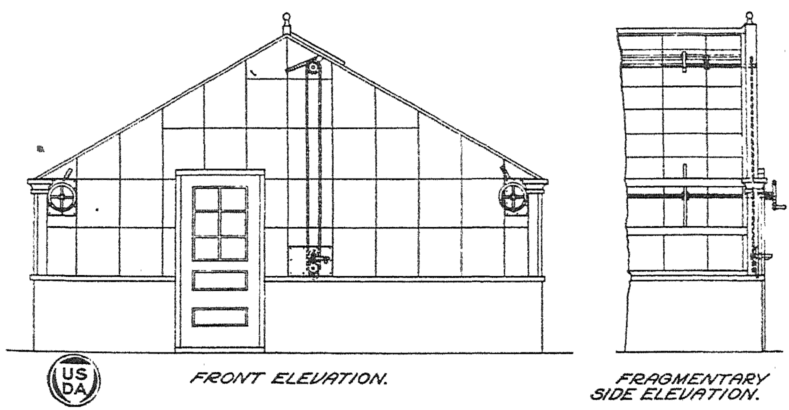


Fig. 5.—Device for opening ventilators from outside.

ducted during April, May and June 1923, in a 200 cubic foot fumigating box. Twenty cubic centimeters of the liquid hydrocyanic acid testing

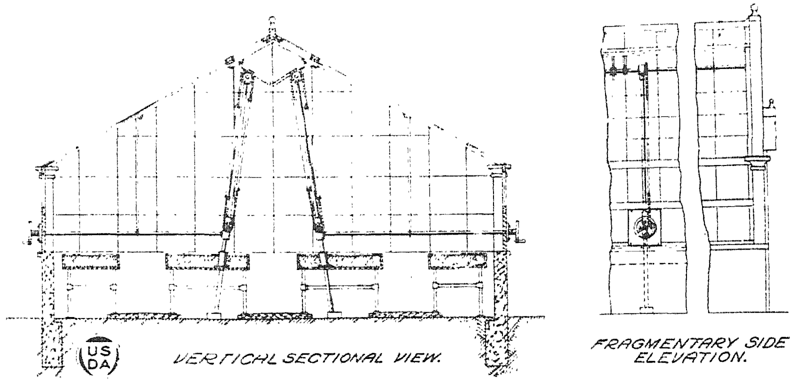


Fig. 6.—Device for opening ventilators from outside.

over 95% purity were used as the equivalent of 1 ounce sodium cyanide[1].

It is obvious from the above table that the equivalent of ¾ ounce sodium cyanide per 1,000 cubic feet of space (or 15cc of liquid) was effective against the following common greenhouse insects, *Idiopterus* sp., *Illinoia pelargonii*, *Myzaphis* sp., *Macrosiphoniella sanborni*, *Myzus persicae*, *Trialeurodes vaporariorum*, *Orthezia insignis*, *Chrysomphalus biformis*, *Coccus elongatus*, and *Thrips tabaci*, killing from 97 to 100 per cent of them. This dosage, however, was not effective against the immature stages of white fly, *Trialeurodes vaporariorum*, or the adults and eggs of the azalea bark scale, *Eriococcus azaleae*, and mealybugs, *Pseudococcus citri*, or the eggs of the long soft scale, *Coccus elongatus*. Slight tip burning occurred only on chrysanthemums, rose, and Jerusalem cherry. These results also demonstrate that liquid hydrocyanic acid is equally as effective as the pot method of generating the gas.

Upon carrying the experiments to the greenhouse it was necessary to determine the distribution of the gas and its effect on the hosts. The plants in the experiment were divided into three lots, with one lot at each end and one in the middle of the house. One plant of each variety was represented in each lot and arranged in the same order so that if burning occurred it would be in evidence on the same variety of plants in each lot and this would serve as an index of equal distribution of the gas. Burning occurred on one variety of jasminum in each lot of plants indicating that comparative equal diffusion had taken place.

It is evident from the experiments thus far conducted that while this

[1]Woglum, R. S., "Fumigation of Citrus Trees for Control of Insect Pests," Farmers' Bulletin 1321, p. 26, 1923.

gas may have an efficiency equivalent to the gas produced by the pot method, the manner of application has not reached the stage where it could be safely recommended to the average florist. The advisability of conducting this gas into a greenhouse by means of a force pump and then liberating it under pressure through a system of perforated pipes with adjustable nozzles permanently installed near the ridge of a house is now being made the subject of a special investigation.

Plant Tolerance Experiments With Kentia and Areca Palms

The regulations of the Louisiana State Department of Agriculture prescribe that nursery stock and plants originating within the camphor scale infested area and which are offered for sale interstate or intrastate must be hand inspected and fumigated with hydrocyanic-acid gas under supervision prior to shipment. In connection with this work the State inspectors frequently noted that Kentia palms in particular were severely burned when exposed to the gas at the ¾ ounce dosage sodium cyanide per 1,000 cubic feet of space. It seemed necessary, therefore, to conduct tests to determine the reason for the burning. The results of these experiments which were conducted at New Orleans by the junior author and W. D. Whitcomb during January and February 1923, demonstrated the following:

All experiments show that *Kentia belmoreana* are burned to some degree if exposed for 1 hour to hydrocyanic-acid gas with a concentration of ¾ ounce sodium cyanide, or greater, per 1,000 cubic feet of space with humidity ranging from 56 to 86 per cent.

Exposure to sunlight both *before* and *after* treatment tends to intensify the burning but the results were not all uniform. Fronds exposed *directly* to the light before and after were more severely burned.

Wetting the plants prior to fumigation did not materially influence the results.

No burning was observed on new spikes. There was no apparent difference in the tolerance of old and new fronds.

Experiments with *Areca lutescens* indicate a much greater resistance to hydrocyanic-acid gas. However, some burning occurred under such unfavorable conditions as a humidity of 75 to 80 per cent and exposure to strong sunlight after treatment.

It is evident from the results thus far obtained that Kentia palms cannot be fumigated with hydrocyanic-acid gas, even as low as ¾

ounce, without severe injury unless the plants are protected from sunlight for a period greater than 48 hours after treatment.

Incidentally it might be well to mention the fact that during the above tests the 1 and 2 ounce dosages per 1,000 cubic feet were repeated in order to verify the results of the previous season on the effectiveness of these dosages against the eggs of *Pseudaonidia duplex* at temperatures ranging from 46° F., and higher. Since crawlers hatched at the 1 ounce strength it indicated that it is not effective during low temperatures.

Miscellaneous Results with Hydrocyanic-Acid Gas

Additional data has been accumula ed at intermittent periods during the year on the efficiency of this gas, some of the outstanding results of which are as follows: The 2½ ounce rate killed 100 per cent of the soft brown scale, *Coccus hesperidum* (L), and the chaff scale, *Parlatoria pergandii* Comst., but was only partially effective in controlling larvae of the azalea leaf roller or miner, *Gracilaria azaleella*, and the azalea bark scale *Eriococcus azaleae* Comst. Results of plant tolerance experiments indicated that poinsettias when the bracts had developed their intensity of red color can stand as high as 1½ ounces, and that azaleas may be fumigated as high as the 5 ounce per 1,000 cubic feet rate although it caused tip burning of one variety.

Calcium Cyanide as a Greenhouse Fumigant

During the past summer samples of calcium cyanide in granular and dust form were received from Dr. Wm. Moore and experiments were undertaken to determine their value as greenhouse fumigants. Preliminary experiments in a 200 cubic foot box with the dust were made and more recently similar tests were conducted under actual greenhouse conditions. In the box tests the calcium cyanide dust was spread over damp newspapers in amounts equivalent to from one-half to one ounce of sodium cyanide per 1,000 cubic feet and the plants were exposed for one hour to the gas evolved. Two species of aphids were used viz: *Macrosiphoniella sanborni* on chrysanthemums in experiments 1 to 9, and *Illinoia pelargonii* on geraniums in experiment 10. Vinca, Jerusalem cherry, Martha Washington geranium, begonia, and Kentia palms were also included and escaped injury. The ¾ ounce rate caused slight tip burning on Lantana and snapdragon, and the 1 ounce rate on chrysanthemums. These results are shown in Table II.

TABLE II. SHOWING CONTROL OBTAINED WITH CALCIUM CYANIDE IN BOX FUMIGATION EXPERIMENTS

Exp. No.	Dosage NaCN in Ounces	Temperature °F	Humidity %	Interval in days	Condition after fumigation dead	alive	Control %
1	¼	71.6	85	1	79	94	45.6
2	do	69.2	90	½	370	7	98.1
3	¾	69.4	90	1	185	2	98.9
4	do	71.6	90	1	111	50	68.9
5	do	72.5	69	1	368	15	96.
6	1	74.3	67	½	280	0	100.
7	do	68.9	91	1	118	15	88.7
8	do	80.6	64	1	165	2	98.8
9	do	82.4	65	1	925	30	96.7
10	do	80.6	64	1	830	0	100.

In the ½ ounce equivalent dosage accurate records of mortality could not be made the same day because some individuals revived after being brought into fresh air. The aphids were only stupefied by fumigation at the ¾ ounce rate when exposures lasted 15, 30, and 45 minutes respectively, and most of them soon recovered.

After these tests were completed it was learned that spreading the dust directly on the moist newspapers caused complex reactions which may have reduced the amount of hydrocyanic-acid gas actually released.

Plant tolerance tests of the dust were then made under greenhouse conditions. For this purpose 8 varieties of plants known to be very sensitive to hydrocyanic-acid gas were selected. Ten plants of each variety were fumigated at rates equivalent to ½, ¾ and 1 ounce of sodium cyanide per 1,000 cubic feet for one hour. The temperature and

TABLE III. SHOWING TOLERANCE OF DIFFERENT VARIETIES OF PLANTS WHEN FUMIGATED UNDER GREENHOUSE CONDITIONS WITH CALCIUM CYANIDE

Host	Degree of burning at dosages equivalent to sodium cyanide in ounces ½	¾	1
Ageratum	Slight	None	Severe
Coleus	None	None	None
Artemisia	None	None	Slight
Heliotrope	Very slight	Very slight	Severe
Jasminum grandiflorum	Tip very slight	Tip slight	Tip severe
Lantana elegantissima	None	None	None
Ipomoea grandiflora	None	None	Slight
Salvia	None	Slight	Severe

humidity conditions for these experiments were as follows: 73° F., and 84%; 72°F., and 75%; and 68 F., and 83%.

The dust was applied in the units to be fumigated by means of a small hand duster to insure equal distribution. Since hydrocyanic-acid gas is given off when the particles of calcium cyanide dust are exposed to moist air it was assumed that by forcibly blowing the material into a greenhouse a nearly complete reaction should take place resulting in a maximum liberation of gas. Encouraged by the slight degree of injury indicated in Table III, a larger house of approximately 18,000 cubic feet of space involving many varieties of bedding and ornamental plants was fumigated in the manner just described, and with similar results.

From the evidence of plant tolerance thus far obtained with very susceptible plants it seems likely that this material can be adapted for greenhouse fumigation purposes. However, considerable investigation remains to be done before its status as a greenhouse fumigant can be definitely assured. These investigations involve (1) perfecting methods of application, (2) determining the rate of evolution of gas under varying atmospheric conditions, and (3) ascertaining its insecticidal efficiency.

PRESIDENT A. G. RUGGLES: The next paper, will be read by C. C. Compton.

THE USE OF LUBRICATING OIL EMULSION ON GREENHOUSE SCALE INSECTS

By C. C. COMPTON, *Natural History Survey, Urbana, Ill.*

ABSTRACT

Lubricating oil emulsion spray at 1% strength has proven very effective in controlling scale insects, Coccidae, under greenhouse conditions. No injury to palms has resulted from the spray at this strength with the exception of one case of very slight injury when the application was made on a very cloudy day. On bright, sunny days a spray at 2% strength has been used without injury but is not recommended.

There is a distinct demand for an insecticide for use in combating scale insects on greenhouse plants. Since scale insects are most troublesome on foliage plants, grown largely for the attractiveness of their leaves, it is important to have an insecticide that will not injure the foliage and yet be effective against the scale. The work with this emulsion was carried on by the writer in the Chicago district during 1922 and 1923.

The lubricating oil emulsion spray at 1% strength has proven itself 90–100% efficient in controlling scale insects on palms and rubber plants without injury to the foliage. In large amounts the stock emulsion is used at the rate of 1½ gallons to 100 gallons of water. For smaller amounts 2 ounces to 1 gallon of water is satisfactory.

PREPARATION OF "BOILED" LUBRICATING OIL EMULSION FORMULA FOR STOCK EMULSION

Oil—(Sp. Gr. 0.886—viscosity 365.3—Volatility 4.9%	1 gallon
Water	¼ gallon
*Potash fish-oil soap	2 pounds

The water, soap and oil are placed in a kettle or other receptacle and heated to a boil. Boil for about five minutes being careful not to burn the mixture, remove from the fire or turn off the steam and pump twice at a pressure of 50 to 150 pounds. Make sure that all the mixture passes thru the pump twice. Do not allow the mixture to cool before pumping.

A barrel pump has been found adequate for preparing the emulsion in sufficient quantities for greenhouse work.

Precaution should be taken to prevent the stock emulsion from freezing.

The following are the most troublesome and destructive of the scale insects with which we have to deal in greenhouses in this district, they are given in the order of their importance.

Palms and *Ficus* sp.

(1) The Circular or Florida Red Scale, *Chysomphalus aonidum* Linn., commonly found on *Kentia* sp., *K. forsteriana*, *K. belmoreana*, *Phoenix* sp., *Latania borbonica* and *Ficus* sp.

(2) The Oleander Scale, *Aspidiotus hederae* Vall. Commonly found on *Kentia* sp., *Phoenix* sp., and the areca palm, *Areca verschaffeltii*.

(3) The Tessellated Palm Scale, *Lecanium tessellatum* Sign., found principally on *Kentia* sp. and the areca palm, *Areca verschaffeltii*.

Ferns.

(1) The Fern Scale, *Hemichionaspis aspidistrae* Sign., which is most destructive on the Boston fern.

*The amount of soap depends on the hardness of the water. In this work I have used 2 pounds in every case.

Control Experiments

Table No. 1.

Plant	Scale infesting plants	House Day	Temp. Night	Result of examination after 48 hours No. Live scale	No. Dead scale	Percent killed	Injury to plants
(1) Kentia sp.	Fl. Red Scale, Oleander Scale	70	60	27	268	90	None
(2) Kentia sp.	F. R. Scale, Ol. Scale	70	60	0	240	100	None
(3) Phoenix sp.	F. R. Scale	70	60	7	304	98	None
(4) Kentia sp.	F. R. Scale	70	60	6	294	98	None
(5) Ficus sp.	F. R. Scale	70	60	0	70	100	None
(6) Latania borbonica	F R. Scale	70	60	0	242	100	None
(7) Boston Fern	Fern Scale	70	65	0	40	100	Severe

Remarks: In every case the emulsion was used at 1% strength and was applied in the morning. Six inch sections of leaves were marked off with paper clips. The spray was applied with a compressed air sprayer. Forty eight hours after the spray was applied counts of the dead and live scale were made as above. In every case the application was made on a bright, sunny day.

Table No. 2.

Plant	Scale infesting plants	House Day	Temp. Night	Result of examination after 48 hours No. Live scale	No. Dead scale	Percent killed	Injury to plants
(1) Kentia sp.	F. R. Scale, Tessellated P. Scale	65	60	8	192	96	Very slight
(2) Areca sp.	Tessellated P. Scale	70	60	5	120	96	None
(3) Phoenix sp.	F. R. Scale, Ol. Scale	70	60	0	122	100	None
(4) Ficus sp.	F. R. Scale	65	60	0	110	100	None

Remarks: Emulsions used at 1% strength and applied in morning. Sections of leaves marked off as in Table No. 1 and counts made in the same manner. The spray was applied with a barrel pump. Spraying was done on bright, sunny days with the exception of (1) when the spray was applied on a very dark day.

As the tables above will show this spray has given excellent control

of scale insects on palms and Ficus sp. One case of very slight injury to the newly formed leaves of *Kentia belmoreana* was observed. Table No. 2 (1). The house temperature at this time was 65 degrees and the spray was applied on a very dark day followed by several cloudy days. On bright, sunny days the emulsion has been used at 2% strength on Kentia sp. without injury to the foliage but is not recommended since the 1% strength is sufficient to give 95–100% control with one application. Besides killing the live scale on the plants this spray loosens the dead scale and old scale covering eggs so that syringing under pressure at the time of watering will rid the plants of both. The spray also spreads and sticks very well and will remain on the plants several weeks. For this reason young scale are prevented from becoming established, particularly *Lecanium tessellatum* Sign., which is viviparous. Leaves of plants sprayed are given a clear and healthy color and dirt or dust that collects on the plants is more readily washed off the sprayed plants than is the case with the unsprayed plants.

The lubricating oil emulsion spray is equally effective in controlling the Fern Scale, *Hemichionaspis aspidistrae* Sign., but is not recommended because of the liability of injury to the foliage of the plants. See table No. 1 (7).

PRESIDENT A. G. RUGGLES: A paper will now be presented by Mr. J. R. Watson.

CONTROL OF ROOT-KNOT NEMATODES ON FLORIDA TRUCK FARMS

By J. R. WATSON

ABSTRACT

Starvation. Culture of an immune cover crop during the summer with constant cultivation to keep down weeds and prevent encysting.

Soil Fumigation. Use of a combined treatment of sodiun cyanide and ammonium sulphate; Calcium cyanamid; calcium cyanide; sulphur.

Heat as a control measure.

Flooding as a control measure.

Incidental control of insects in the soil.

Perhaps some of the members may feel that a paper on nematodes is a bit out of place in a meeting of entomologists, but in our southern states, at least, some one must tackle the problem, and generally the choice lies between the entomologist and the plant pathologist, and a nematode is certainly more closely related to an insect than to a fungus.

Furthermore, the work of soil fumigation admits of wide application to injurious insects as well.

In our work in Florida we have approached the subject largely from the view point of the gardener and trucker. For the general farmer, and even for the farmer who combines considerable trucking with his staple crops, the cheapest and most desirable method of dealing with this pest is doubtless the time-honored one of rotation of crops, growing for two or three years on the infested land crops more or less resistant to the nematodes, such as corn, grains, Brabham, Iron, or Victory cowpeas, velvet beans, etc. But the time involved is a serious objection to one practicing more intensive trucking. He cannot afford to devote his high-priced land to the above mentioned crops with their relatively low return per acre, and most truck crops are seriously affected by the root-knot organism. To meet the needs of the trucker an endeavor has been made to find a quicker method of controlling the pest. However, even for the intensive trucker, rotation of crops should not be abandoned. We have accumulated considerable evidence that there are among the nematodes strains which have become adapted to certain crops. We have repeatedly observed that when a crop of lettuce, for instance, heavily infested with root-knot, is harvested from the land, the land can at once be set out to celery with comparatively little damage, whereas a second crop of lettuce on the land is seriously affected. These observations are in direct contradiction to those obtained by Bessey on this subject and will need careful verification by pot experiments before we can consider the question settled.

In all our work commercial control rather than complete eradication has been our aim. Florida soils, unless newly cleared, are so universally infested with nematodes that even if we should completely eradicate the pest from a piece of ground it would be very quickly reinfested from surrounding plots, as is newly cleared land. Our aim, therefore, has been rather to reduce the nematodes to such an extent that the farmer is able to grow a susceptible crop on the land during the next trucking season. This is much less expensive than would be complete eradication.

Our work has been largely along two lines, starvation and soil fumigation.

Starvation

The Florida trucking industry has a favoring circumstance in the fight against nematodes in that it is limited to the fall, winter, and spring months, leaving the land unoccupied during the summer, the most active season for nematodes. Formerly it was almost universal to

abandon the fields after the last truck crop was harvested to grass and weeds. Among these would be enough hosts of the nematodes to carry the infestation thru the summer. Furthermore, the heavy rains of the summer compact the soil to the exclusion of the optimum amount of air, as shown by the general acid reaction of such ground. These conditions tend to keep the nematodes in the encysted state so that they are carried over until trucking operations are begun again in the fall.

One of our earliest attempts to control nematodes in infested land was by means of the summer fallow, the idea being to keep the soil constantly stirred and aerated so that the eggs would be forced to hatch, and at the same time to keep the land barren of all vegetation, in order to starve out the nematodes. The land was accordingly plowed and harrowed at itervals of ten days and after every heavy rain that packed the soil. A crust was never allowed to remain on the land. This kept the soil well aerated, and this in connection with the abundant moisture and high temperature of the summer season forced the eggs to hatch. As far as nematode control is concerned this procedure has worked out very well, but as was to be expected the effect on soil fertility is very deleterious. The hot sun on the bare ground and the heavy rains cause the loss of a large part of the plant food and are very injurious to soil organisms. However, the method is still occasionally used by a number of truckers who regard their farms only as a site for growing crops, expecting to buy their soil from the fertilizer salesman.

In an endeavor to avoid the injurious effects of the summer fallow we modified it by growing on the land some practically immune plant but maintained the constant cultivation and freedom from weeds, the idea being to shade the ground and thus prevent the injurious effects on the soil fertility; at the same time preserving the beneficial effects of constant cultivation. For a cover crop we turned to velvet beans for two reasons. In the first place they are practically immune to root-knot, being much more resistant than Brabham, or any other variety of cowpeas, and in the second place they make a rank growth during the summer time and completely shade the ground. It is to be observed that this method differs from the old method of crop rotation in that the land is kept under constant cultivation and a crust is never allowed to remain on the soil; also in the more careful elimination of weeds and grass. To secure this result, one or two hoeings when the velvet beans are young are necessary, and very frequently a hand weeding in the row as well. The results have been very satisfactory. Generally we have secured as thoro a control of nematodes in one summer from

June or July to October as we secured by the older and more careless method of crop rotation in two or three years. In every case where the method has been carefully applied it has reduced the nematodes to a point where it was possible to profitably grow highly susceptible plants such as okra thruout the succeeding trucking season.

Soil Fumigation

Seed beds present another problem calling for more complete eradication of nematodes, particularly in the case of crops like celery or lettuce, which are planted in the summer when nematodes are most active. On the other hand, the limited area and the high value of the crops, justifies more expensive methods. Undoubtedly, steam or hot water is the most effective method of ridding the soil of nematodes, and where the trucker has steam handy it is undoubtedly the most satisfactory method of treating seed beds, but unless the land is piped for steam we have found steaming a very expensive process. It was tried on the pineapple lands of the East Coast but the cost was prohibitive. The same objection applies to hot water. The expense involved was largely that of transporting the boiler or other outfit from place to place.

We have tried carbon bisulphide and formalin and find them very good soil fumigants for nematodes, but on the whole we have had the best success, considering the cost, with a double treatment of sodium cyanide and ammonium sulphate. This was first tried, so far as the speaker knows, a number of years ago in California by Professor Woodward on a small scale. In practice, the soil is first saturated with a solution of sodium cyanide in water. We find that the dosage required will vary much with the type of soil. In general the lighter the soil the smaller the dosage required. On the sandy soils of the average trucking regions of Florida we have found that 600 pounds of sodium cyanide per acre is usually sufficient. This is applied in water and washed down with a liberal irrigation (most seed beds in Florida are provided with overhead irrigation.) Ammonium sulphate is then added at the rate of 900 pounds to the acre. This is also washed down with a light irrigation. The ammonium sulphate acts on the sodium cyanide producing hydrocyanic acid gas. We find this method very effective, not only in killing out the root-knot organisms, but all animal life in the soil is killed. The seeds of most weeds are also killed, but those with large, heavy seeds will usually survive the treatment, as will also heavy Bermuda grass sod. Of course, covering the ground with some gas tight material, such as tarred paper or a cloth treated with

rubber (we have found the material from which the tents for fumigating citrus trees are made to be very satisfactory) will greatly increase the killing effects of the fumigation and reduce the dosage necessary.

The expense of this treatment is high. It costs nearly $200 per acre, but as the acreage is usually small the above expense is not prohibitive for seed beds. The residue, of ammonium sulphate, left in the soil increases the soil fertility and causes rapid growth of the plants.

We find that we can ordinarily safely plant the soil in ten days to two weeks after treatment. We have tried the sodium cyanide alone without the ammonium sulphate but the results were not nearly as satisfactory. The evolution of gas was not sufficiently rapid and the cyanide remained in the soil for a considerable time. It was difficult to get rid of it.

We are now experimenting with calcium cyanide, both in the form of dust and flakes. It would seem that we will be able to substitute this material for the sodium cyanide and ammonium sulphate at a greatly reduced cost. We have found the most satisfactory method of applying this material is to sprinkle it in the furrow when the land is plowed.

Drowning

It has long been observed that lands regularly kept under water for several months each summer were never seriously affected by nematodes. The flooding of the Everglades last year offered us opportunity to secure some data on the length of time necessary for eradication of nematodes. We found that soils continually under water for as much as six weeks still had plenty of nematodes, but fields submerged for four or five months were in all cases free. It would seem as if the time necessary to drown out the nematodes is too long to make this method of much practical benefit.

Mr. R. A. Cooley: I would like to ask if the cyanide treatment of the soil had any effect on the soil organisms?

Mr. J. R. Watson: It did not seem to have much effect.

Mr. H. F. Dietz: I would like to ask Mr. Watson if he has had any experience in getting perennial plants to outgrow the nematodes. This is a problem which I think will be important in the next few years, especially in connection with hardy perennials.

Mr. J. R. Watson: We are running tests along these lines but thus far they have not been very satisfactory.

MR. E. W. BERGER: A little test that I made in 1922 may serve as a near-answer to Mr. Dietz's question. I had trouble with Root-Knot Nematode severely infesting a few rows of Swiss chard in my garden. I transplanted several small plants into two flower-pots, being particular to select plants equally infested, and used infested soil from the same spot in the garden.

The soil in one pot was regularly drenched (perhaps, on an average, once per week) with a one-tenth per cent solution of glacial acetic acid in water (later 2-tenths per cent was used), while the soil in the other pot was always drenched only with an equal amount of plain water. Both were treated alike as to fertilization.

It was soon apparent that the plants receiving the weak acid were doing much better. When, after several months (February to June, 1922), the plants receiving only water died, examination showed that the treated plants had developed an abundance of apparently healthy rootlets, which was not the case with the plants that had received only water. The treatment had evidently checked the development of the nematodes in the soil, allowing the development of healthy or nearly healthy rootlets, whereas the roots of the untreated plants were unusually full of nematode-knots.

MR. W. E. HINDS: For a number of years we have used sodium cyanide solution alone, particularly in treatment of green house soils, with fairly satisfactory results so far as the control of nematodes is concerned, and with beneficial results so far as the growth of vegetation is concerned. This treatment is practicable with lettuce, squash, and crops like that of a truck nature. Its use would seem to be justified entirely from the fertilizer standpoint alone. Planting just as soon as the soil is dried out enough to plant any seed has seemed to be safe. A solution of 1 oz. sodium cyanide in 8 gallons of water is applied at the rate of 1 gallon per square foot of area.

PRESIDENT A. G. RUGGLES: The next paper will be read by Mr. K. C. Sullivan.

THE USE OF CALCIUM CYANIDE FOR THE CONTROL OF FLEAS AND OTHER INSECTS

By K. C. SULLIVAN, *Columbia, Mo.*

ABSTRACT

Calcium cyanide was successfully used for the control of the Dog fleas (*Ctenocephalus canis* Curtis) and the Human flea (*Pluex irritans* L) in both open and closed buildings. Calcium cyanide used at the rate of four ounces per 100. sq. ft., will

give practically 100% kill in closed buildings. Eight ounces to 100 sq. ft., in open buildings will give the same results.

Calcium cyanide dust was successfully used for controlling blister beetles (*Epicauta vittata* Fab.), in gardens.

Used at the rate of one ounce to 1500 cu. ft., of space, calcium cyanide dust gave a 95% kill of white fly (*Aleurodes vaporariorum* Westw.) in greenhouses without any injury to plants.

Calcium cyanide dust gave fair results when used at the rate of one ounce to 25 cu. ft., one ounce to 50 cu. ft., and one ounce to 100 cu. ft., for periods varying from 45 minutes to one hour, for the control of San Jose scale (*Aspidiotus perniciosus* Comst.) on nursery stock, apple and peach.

During the past year calcium cyanide has been used at the Missouri Agricultural Experiment Station for the control of a number of different insect pests. Due to the fact that Calcium cyanide is a new product most of the work with it up to the present time has been purely experimental. However, in a number of cases it has been used with very great success in a practical way and on a large scale. The results which have so far been obtained lead us to believe that calcium cyanide has many possibilities and that in the future it can be safely and successfully used for the control of not only certain insect pests but also certain other types of animals such as rodents which destroy annually large quantities of agricultural products. It must be remembered, however, that its use as a remedy for controlling insects is still largely in the experimental stage. In most cases methods of application must be worked out and the dosage necessary to kill particular insects determined. In other words, from the standpoint of an entomologist there are many things which we do not know about calcium cyanide. Therefore, in this paper I shall attempt only to point out some of the possibilities of calcium cyanide when used for the control of fleas and other insects and give a brief resume of the results which have been obtained during only one seasons work. Additional work may, and I believe will, substantiate the results which have been obtained, but on the other hand further experiments should be carried out before definite conclusions are drawn.

Calcium cyanide being a material which gives off hydrocyanic acid gas, one naturally infers that it can be used for fumigating purposes. It may be obtained in three different forms—flakes, granules and dust.

On coming in contact with moisture either from the air or the soil the hydrocyanic acid gas is given off. All of the different forms are easy to handle and where it can be successfully used the process of fumigating is greatly simplified. In some instances it is more desirable to use the

dust form than either the granules or the flakes, as the hydrocyanic acid gas is given off more rapidly from the dust.

During the past summer fleas were very plentiful in Missouri especially through the central portion of the state, with the result that ample opportunity was offered to make some rather extensive tests with calcium cyanide. The credit for the work with fleas is largely due Mr. S. W. Bromley. This work was carried on in cooperation with the Department of Entomology of the Missouri Agricultural Experiment Station.

The first test made was in a modern dwelling house in Columbia, Missouri on July 20, 1923. An Airdale dog was allowed to sleep on the second floor with the result that this floor became badly infested with the dog flea (*Ctenocephalus canis* Curtis). After the infestation was discovered the dog and two cats were kept out doors. The floors were new and of hard wood. The fleas were evidently in the rug, and upon entering this floor numbers of the pest would jump upon the trousers. No fleas were observed in any other part of the house.

The house was fumigated with calcium cyanide flakes at the rate of 4 ozs. to 100 cu. ft. on the second floor where the infestation was present, and one ounce per 100 cu. ft. on the first floor and the basement. The flakes were put down at 8:30 in the morning, the house emptied of its inhabitants and all the windows and doors closed. The flakes were scattered on newspapers on the second and first floor and on the concrete floor in the basement. Flakes were also scattered outside in the new sleeping quarters of the cats and dog, and the animals were treated with kerosene emulsion.

At 5:30 P. M. the house was opened and the newspapers and flakes removed. The flakes were still giving off some gas. A number of dead fleas were shaken from the rug in the badly infested room. During the next few days three or four fleas were found in clothing which were evidently brought in from the outside. No further trouble was experienced and the owner was well satisfied with the results.

Similar results were obtained in the basement of a store in Columbia, Missouri. The owner kept a dog in the basement and it became so badly infested that he feared the fleas would find their way up stairs and attack his customers. The basement was tightly closed and the door fixed so it could be opened from the outside. At 7:30 P. M., July 26, 1923, flakes were scattered on the concrete floor at the rate of two ounces to 100 cu. ft. The place was opened the next morning at

7:30 and no live fleas could be found. The dog was taken to the country and the owner had no more trouble.

The space under the porch of a dwelling house in Columbia, Mo. became infested with fleas from a dog which bedded there. The owner spent a few minutes under this porch one day examining some pipes and afterwards killed twenty-two fleas on his clothing. The dimensions of the space under the porch was ninety square feet. At 4:15 P. M. August 1, 1923 a little less than two pounds of 50% calcium cyanide dust was uniformly scattered. Three days later no fleas could be noticed under the porch but upon examining a quantity of the debris in the laboratory one live flea was found.

The barns, sheds and hog houses on a farm near Columbia, Mo. became very heavily infested with the human flea (*Pulex irritans* L.) The fleas were so bad that the owner had trouble keeping hired help. Calcium cyanide flakes were scattered by hand at the rate of four ounces to 100 sq. ft. on newspapers which had been spread down in the different buildings. The flakes were put down at 7:30 P. M. July 24, 1923. The newspapers were used so that the residue could be easily cleared away as poultry and hogs had the run of most of the buildings. Wherever possible the buildings were closed but some of the sheds were open on one side. There was no breeze. Conditions were as nearly ideal as possible. The next morning the premises were carefully examined and no living fleas were found except in the tool shed. In this building a few had survived. The application was repeated in this building using eight ounces to 100 cu. ft. Not a single living flea could be found one hour later.

Calcium cyanide used at the rate of eight ounces to 100 sq. ft. can be depended upon to give practically a 100% kill. In a building which can be closed, four ounces to 100 sq. ft. will give the same results.

Some interesting results were also obtained in using calcium cyanide for the control of blister beetles on garden and truck crops. Tests were made with the 50% dust on the striped blister beetle (*Epicauta vittata* Fab.). This blister beetle made a sudden attack on a small garden of about 255 feet square. They were feeding heavily upon beets, and potatoes. A knapsack duster was used and the application was made at about 4:00 P. M. on July 27, 1923. About two pounds of dust was used. Most of the beetles were killed almost instantly. Some, the gas seemed to paralize. First, the rear pair of legs became useless. The beetles would try to pull themselves along with the first two pair when shortly the second pair would cease to function. Then

in a short time the first pair of legs would become useless. The antennae seemed to be the last organs which were affected. Naturally a few of the beetles escaped before they got enough gas to stop them, also a very small number of the beetles revived enough to crawl away. The garden was examined the following morning. Some of the beetles on the ground were still able to slightly move their legs and antennae. A number of these were collected and brought in the laboratory .Twenty-four hours later they were all dead. Very few of the beetles escaped and the injury they did to the garden was slight. Similar results were obtained in every case where calcium cyanide dust was used for the control of blister beetles.

A few tests were made with calcium cyanide on squash and melon vines for the control of the striped cucumber beetle (*Diabrotica vittata* Fab.), and the squash bug (*Anasa tristis* DeG.). Calcium cyanide flakes used at the rate of one teaspoon per hill killed both the insects and the plants. The granules and the dust gave the same results. Equal parts of calcium cyanide dust and air slacked lime used at the above rate showed no injury to the plants but did not give satisfactory control. However, from the results obtained it seems probable that it will be possible to work out a dosage which can be used satisfactorily for the control of melon pests.

Plant lice succumb quickly to very small quantities of calcium cyanide dust. The dust was successfully used on melons and on Spiraea Van Houtti. It was applied with a small hand bellows. The aphids were almost instantly killed and without injury to the plants.

Recently the Department of Horticulture of the Missouri Agricultural Experiment Station has been depending upon calcium cyanide dust for the control of the white fly (*Aleurodes vaporariorum* Westw.) in their greenhouses. The results have been entirely satisfactory. It was first used last May in a greenhouse containing young tomato plants which were badly infested with white fly. The house contained 7758 cu. ft. of space. Eleven ounces of dust was used. It was evenly distributed on the beds thruout the house and some of the dust was placed directly on the leaves. The application was made at 6:10 P. M. May 23, 1923. The house was opened the next morning at 4:35. All adult flies were dead. Most of the larvae and eggs were killed. The pupa appeared to be alive. Seven days later several adults had emerged from the pupa and the few eggs which had not been killed were hatching. Where the calcium cyanide came in contact with the leaves it caused serious

burning, otherwise the plants were not injured. It requires two treatments to thoroughly clean out an infestation of white fly.

A greenhouse containing over fifty different kinds of plants was fumigated December 17, 1923 using one ounce calcium cyanide dust to 1,000 cu. ft. A 95% killl of white fly was obtained and no plants were injured. A temperature of 60 F. was maintained and the house was allowed to fumigate from 7 P. M. to 7 A. M. Calcium cyanide dust used at the rate of one ounce to 2,000 cu. ft., temperature 60° F., gave a 25% kill. The ease and safety with which calcium cyanide can be used seems to indicate that it has possibilities of becoming the standard remedy for the control of white flies in greenhouses. Its effect upon other greenhouse pests has not as yet been studied.

On November 13, 1923 a series of experiments were started to determine the value of calcium cyanide for fumigating nursery stock infested with San Jose Scale (*Aspidiotus perniciosus* Comst.), apple and peach trees were used. The apple trees had two seasons growth from graft, the peach trees were cut backs but with two seasons growth. They were grown in an experimental nursery and were badly infested with San Jose Scale. Many of the peach were almost encrusted. A tight fumigating box was used. Calcium cyanide dust was used at the rate of 1 oz. to 25 cu. ft.; 1 oz. to 50 cu. ft.; 1 oz. to 100 cu. ft.; 1 oz. to 200 cu. ft. and 1 oz. to 400 cu. ft. Five sets of trees were used for each strength. The first set was allowed to fumigate for 30 minutes; the second 45 minutes; the third 1 hour; the fourth 1¼ hours and the fifth 2 hours. The trees were dug and placed directly in the fumigating box. The desired quantity of calcium cyanide dust was then spread out on a dry board placed in the center of the box about half way between the bottom and top. After fumigating the trees were reset, and ten days later the first counts were made. With every test enough scales were counted to get a fairly accurate average of the percentage of scale killed. The first or the ten day count showed that none of the treatments resulted in a 100% kill. In one case (1 oz. to 200 cu. ft. for 30 min.) only 70% of the scales were dead but in most cases the kill was better than 90%. About three weeks after fumigating counts were again made on the first three sets of trees. This time 100% of the scale were dead in eight out of fifteen cases. Then again about five weeks after fumigating the third counts were made on all of the twenty-five different tests. Live scales were found only on nine. The following table shows a complete record of all counts made and the results obtained.

The Use of Calcium Cyanide for the Fumigation of Peach and Apple Trees for San Jose Scale

				Percent scale dead for different periods of treatment				
Amount of material used	Date of treatment	Date counted	Kind of tree	30 Min.	45 Min.	1 Hr.	1½ Hrs.	2 Hrs.
1 oz. to 25 cu. ft.	11/13/23	11/23/23	Peach	90.5	94.5	96.4	99.3	83.5
	11/13/23	11/30/23	Peach	96.5	99.0	96.5	99.0	94.5
			Apple		100.0			
	11/13/23	12/21/23	Peach	100.0	100.0	100.0	98.5	100.0
			apple		100.0	100.0		
1 oz. to 50 cu. ft.	11/16/23	12/26/23	Peach	83.3	90.0	94.0	96.8	96.8
			Apple		100.0			
	11/16/23	12/6/23	Peach	91.0	100.0	100.0	96.8	98.5
			Apple	99.2				
	11/16/23	12/20/23	Peach	100.0	100.0	99.5	100.0	100.0
			Apple	100.0	100.0	100.0	100.0	100.0
1 oz. to 100 cu. ft.	11/17/23	11/28/23	Peach	98.6	95.0	90.5	91.7	96.5
			Apple		96.0		92.3	
	11/17/23	12/7/23	Peach		100.0		100.0	94.5
			Apple	100.0	99.0	98.6	100.0	
		12/20/23	Peach		100.0	98.6	100.0	100.0
			Apple	100.0	100.0	96.8	100.0	100.0
1 oz. to 200 cu. ft.	11/20/23	11/30/23	Peach	70.0	87.0	93.9	70.0	95.0
			Apple	97.0		93.5		96.0
	11/20/23	12/20/23	Peach	93.5	97.5	99.0	100.0	100.0
			Apple	98.0	100.0		100.0	
1 oz. to 400 cu. ft.	11/24/23	12/6/23	Peach	97.0	50.0	97.7	100.0	95.5
			Apple			86.2	99.0	100.0
	11/24/23	12/20/23	Peach	82.0	68.1	93.7	100.0	100.0
			Apple	54.7		100.0	100.0	100.0
Check..		12/28/23	Peach Percent Scale dead 62.9					
			Apple Percent Scale dead 53.3					

From the results one would naturally draw the conclusion that calcium cyanide kills slowly. However, on the first counts made wherever it was doubtful whether a scale was alive or dead it was considered as a live individual. At the time when the last counts were made there was no question about the live or dead individuals. They were easy to distinguish. This probably explains the difference in the percent of kill between the first and last counts. Also the results seem to indicate that calcium cyanide used at the rate of 1 oz. to 100 cu. ft. will give just as good results as when used at the rate of 1 oz. to 25 cu. ft. The thirty minute treatments gave just as good results as the two

hour treatments at the above strength. With the weaker concentrations the period of fumigation must be lengthened as one ounce of calcium cyanide to 200 cu. ft. and to 400 cu. ft., gave 100% kill only for the 1½ and the 2 hour periods.

The writer has done considerable work with both potassium cyanide and sodium cyanide in the control of scale insects on nursery stock and the results so far obtained with calcium cyanide are practically as good as those which have been obtained with the other materials. However, the writer is not ready to fully recommend calcium cyanide for fumigating nursery stock until additional data have been obtained as to its effect both on the scale and on the plants.

It is hoped that others will pursue the work with calcium cyanide. It undoubtedly offers great possibilities and if additional experiments show that it can be successfully used for fumigating nursery stock the process will be greatly simplified.

QUESTION: I would like to ask the speaker how they applied the cyanide to the green house. And also on peach trees.

MR. K. C. SULLIVAN: In greenhouses, we scattered it on newspapers. We have scattered it on the soil, and it works all right. It can be removed very quickly if placed on newspapers.

MR. J. R. WATSON: I would like to ask if the larvae of the white fly are not killed?

MR. K. C. SULLIVAN: No, it takes two treatments to get the white fly.

MR. J. R. WATSON: We didn't have good results killing larvae.

MR. L. O. HOWARD: Did you have any accidents?

MR. K. C. SULLIVAN: Not in this work on fleas.

MR. D. L. VAN DINE: I'd like to ask the period of exposure.

MR. K. C. SULLIVAN: We usually put it in in the afternoon and take it out in the morning, or put it in in the morning and take it out at night,—about twelve hours.

QUESTION: I'd like to ask Mr. Sullivan to what extent cyanide treatment was used on cucumber beetles?

MR. K. C. SULLIVAN: We used the flakes, the granules and the 50 per cent dust, but we killed the plants in every test we made, except with the 50% dust. Our tests weren't over a very large scale, however, and it is rather hard to draw definite conclusions from the tests we made.

Session adjourned at 12:30 p. m.

Afternoon Session, Tuesday, January 1, 1924

The session convened at 1:30 o'clock.

PRESIDENT A. G. RUGGLES: The first paper on the program is by V. I. Safro.

THE PRICE OF INSECTICIDES

By V. I. SAFRO, *Clarksville, Tenn.*

ABSTRACT

A practical discussion from the standpoint of the salesman and manufacturer designed to assist the purchaser and aid in producing more satisfactory conditions.

When fruit growers demanded that the economic entomologist include with his spraying directions for insect pests information covering applications for fungus diseases, the Plant Pathologist and the Chemist were called into collaboration with the result that the day of spray combinations arrived and today the grower can obtain full directions for an entire season's spraying. Combinations and compatibilities are authoritatively recommended as a result of competent investigations. This development may, perhaps, be considered the greatest recent step in the progress of entomological economics.

It may now be considered proper to suggest that the time has arrived when the economic entomologist can profitably take counsel with the business economist. Large numbers of publications are appearing with the express purpose of teaching the grower cheaper methods of controlling insect pests. The entomologist, notwithstanding his sincere desire to improve the farmer's economic condition, very often proceeds to violate those very principles of economics that he should carefully observe.

Investigators who carefully weigh every entomological fact and word before they permit its publication will too often give voice quite thoughtlessly to economic opinions—and it is the object of these remarks to call attention to this situation—though in doing so, portions of this discussion must necessarily be elementary.

Often the term "prohibitive" appears in publications relative to a consideration of costs of insect control. There is no clear understanding among entomologists of the meaning of this term. When does the cost of insect control become prohibitive to the grower? The writer in a paper in the JOURNAL OF ECONOMIC ENTOMOLOGY some years ago[1] indicated that under certain conditions the total expense of a spraying

[1]Journal of Economic Entomology, Vol. 10, No. 6 p. 521—Dec. 1917.

program may be greater than the value of the crop and still be not only not prohibitive but economically obligatory.

What is meant by "cheaper insecticides"—another term that is very frequently used and regarding which there is considerable uncertainty as to its meaning. There must, of course, always be a search for cheaper insecticides; and furthermore, the search for new insecticides must continue regardless of present prices of materials.

Home manufacture is frequently suggested. If a fruit grower can save fifty percent of the cost of lime-sulfur by making it himself rather than by purchasing the manufactured article, is it necessarily a cheaper insecticide to him? Assuming allowance has been made for the labor value of the growers time, the fuel in cooking and such other usual items of expense that must necessarily be included in any study of comparative costs, another factor of considerable importance is yet to be reckoned with—and a factor that is too often entirely overlooked—this is the factor which for the lack of a more accurate name may be called "convenience."

The economic factor of convenience must not be underestimated. It is the direct motive for that specialization in human activities that is characteristic of modern civilization. What is its value to the individual? Its value is exactly what that individual is willing to pay rather than have to do without.

An attitude of resentment can at times be detected on the part of the present generation of farmers toward the reactionary tendency of agricultural writers to base their recommendations on premises that were not questioned several generations ago; and it is proper for the farmer today to resent the assumption that he is not a seeker after comfort—whatever that term may imply—or that his economic ideas are so undeveloped that he is willing to place his bodily labors always lowest in the scale of economic values.

This factor is repeatedly ignored in official publications. The modern American idea of contingent success is independence. This may mean an opportunity to be lazy, it may mean an opportunity to ride a hobby, but whatever it does mean the underlying thought is that it places the individual in a position where he does just what he pleases to do even though the fact of its pleasure may depend upon whether the work in question is voluntary or obligatory.

When a grower is strongly urged to make his own lime-sulfur it may not always solve matters to suggest that this can be done during the winter, and therefore, should be undertaken by the farmer in order to

fave the few extra dollars that would otherwise go to the manufacturer or relieving him of this work. Directions for home manufacture should, of course, be included for those who are in position to undertake such labor and the recommendations would not be complete unless they were. But directions are equally incomplete when they ignore those growers who prefer to purchase the finished article.

To suggest to a farmer in this connection that he is not using his time to best advantage may give rise to a reaction that may find expression in the farmer's rejoinder that he is sole judge of what it is he most prefers to do. This attitude must not be contrasted with the desire on the part of growers for information as to improved methods, but refers entirely to the assumption that is too often urged upon the grower that whatever he can make himself is necessarily cheaper than anything he can have made for him.

It is in this connection that the economic entomologist can profitably collaborate with the business economist. The problem is not materially modified by stating that as between the grower making a preparation of his own and the factory making one, there are a number of intermediate steps, consisting of the hire of laborers to relieve him of the manual labor —incidentally, perhaps, increasing the responsibilities and opportunities for additional inconvenience. It is for each grower to decide whether he will make a certain preparation or purchase it ready made and the agricultural writer must not take the attitude of dictating the choice. In passing, it is proper to remark that labor in many parts of the country is scarce and must be humored, hence the item of comfort and convenience may apply also to the individual's hired men.

The first thought in the endeavor to obtain cheaper insecticides is often this one of home manufacture. The next evident thought that arises is the desirability of developing other materials or combinations that are not being used at present for that purpose. The opportunities for proper economic guidance in this desire are particularly plentiful.

Assume that a cheaper insecticide is desired for the control of certain pests. It is, of course, first highly advisable to know the cost of the insecticide that it is intended to replace. With this first premise the investigator too often begins in error. Unfortunately, the average entomologist has not the time to ascertain the prices *current* on insecticides, and without this information it is difficult to conduct with any degree of accuracy a study of comparative costs as between an insecticide in use and one in prospect. Nor does it answer the question to inquire of the local dealer the prices of the particular insecticides that he is

handling. It is normally equally unsatisfactory to write to the manufacturer and inquire as to the prices of his insecticides. For competitive reasons, a manufacture may prefer not to reveal his schedule of prices to a non-purchaser.

Except in cases of proprietary preparations or materials having a limited or controlled output, the matter of ascertaining the price of an insecticide is not as simple as is too often taken for granted. The following factors may be suggested as effecting the prices of competitive insecticides and must be included in the matter of price consideration:

There may be a distributor's or jobber's schedule of prices and a retailer's schedule of prices. Each of these factors normally retains for itself a profit. The freight rates on raw material to the factory and the finished product to different consuming districts may effect prices, sometimes considerably. Seasonal sales variations affect prices of commodities normally and insecticides as a class are no exception to such variations. Normally the season of least sales activity with a competitive insecticide would be expected to coincide with the season of lowest quotations. However, this would in turn be affected by such factors as visible and prospective supplies. There are times when the demand is practically nil but the price is maintained because stocks are low. This condition might be susceptible to change if sufficiently large tonnages of insecticides were to move at what is ordinarily the inactive season.

The quantity item in ordering must not be overlooked as a price factor. Some concession can be expected where orders are in larger amounts, where packages are larger in size or even where the greater number of smaller packages are shipped on the single order. This gives the larger purchaser the advantage and whether or not this advantage is passed on to the ultimate consumer is entirely a matter of business relationship between the lot purchaser and the ultimate consumer.

A very important factor affecting the price of insecticides is the manner of payment. A cash payment will very often bring a discount. It is especially important in a consideration of prices that the value of this discount be not underestimated. When interest on borrowed money amounts to from six to eight percent per annum, it is a matter of simple arithmetic to figure out the profit return on a cash discount of two percent for payment in ten days, assuming that the net account is due, say, in thirty days. Where growers' accounts are carried until the end of the season the price factor is further complicated, but the underlying fact must be borne in mind that borrowed money must be

paid for whether the borrowing takes the form of credit extended by a dealer for the purchase of goods or whether the money is actually rented by the borrower. *Very often, cheaper insecticides can be obtained by the grower by a rearrangement of his methods of payment.*

The general credit standing of a prospective or actual purchaser is also a factor. A prospective purchaser who is known to pay his bills when due, ordinarily has an advantage over the purchaser whose credit standing is not satisfactory and he can, at times, obtain lower quotations.

This discussion does not necessarily imply that each purchaser can receive the benefits of all these items as regards his own individual purchases, but it indicates the economic lines along which cheaper insecticides may be obtained.

While these factors refer more evidently to competitive materials, the principles apply, in general, even in the case of non-competitive products. One of the economic functions of a proprietary substance is to remove it, as far as possible, from competitive price behavior. A brand name for a compound often sells it at a higher price than the chemically identical compound purchased as a chemical substance.

Because of lack of sufficient information, the chemical designation of an insecticide cannot always be adopted; but serious consideration, with especially full collaboration of the chemist, should be given to the problem before decisions are made. Consideration should include not only the usual biological and chemical limits of error but also manufacturing variations, which may be greater within the one brand at one time than as between different brands at other times. The history of the development of arsenate of lead exemplifies this principle.

We grant we have ascertained the prices of a certain insecticide and we have discovered a substitute that is composed of ingredients which when properly combined and properly used will have the same or better effect at apparently a smaller expenditure of money on the part of the grower, or perhaps leave a greater profit in its adoption even though the apparent price be greater than the known material or the efficiency be less. This latter item is very important. The fact that one compound yields 95% control and another only 85% control does not of itself justify confining recommendations exclusively to the former substance. That same factor of convenience enters here, together with the other evident economic factors such as cost and efficiency of labor and its supply, the availability of the material and perhaps the limit of choice between 85% control and none. This status is met with in a number of instances where dusting is not as effective as spraying in

the control of pests and yet is the most economical and at times the only method that can be adopted.

The warning underlying this thought is not to discard the inferior method of control without full consideration of all economic factors that may be concerned.

Assuming that the new insecticide seems to have an advantage in price over the old, what are some of the factors that must be considered in order to obtain an idea of its comparative advantage in price to the consumer and to save the investigator from making economic claims that may not materialize.

To begin with, someone must financially sponsor the new material. No matter how simple it seems or how evidently successful it may soon become, someone must risk his money in the venture. It may at this point not be out of place to mention that notwithstanding the greater development of the insecticide industry in recent years, after all it is a small industry compared to those world industries that the general public comes into contact with every day. The insecticide industry is difficult for capital to understand and with capital's well known timidity, it may be mentioned that it is not particularly anxious to rush into the insecticide business, especially when it is understood that, with only a few exceptions, the industry has not been a particularly profitable one. The mistake must not be made of thinking that the funds, equipment and energy of manufacturers already in operation constitute capital any the less for that reason.

Granting that funds have been obtained with which the new development can be undertaken. There is a charge, then, against the new insecticide as a return to cap tal for its use. This is not to be confused with the manufacturing profit that is expected in the conduct of a manufacturing plant. The return to capital for its use must be greater than normal interest returns. There is considerable risk and uncertainty in all business ventures, and the insecticide industry has been no exception to past experience that 95% of all business ventures fail. Hence, capital has a full right to expect return in proportion to the risk involved.

Having obtained financial backing, it is necessary to figure on expense of equipment and installation, on the cost of production, being careful to allow sufficient margin to make up for the under-estimates that practically always occur in such cases, as well as for usual wastages, and for overages in quantities and analyses necessary in fully complying with the laws. It is, of course, assumed that the production of the new material will

be on a sufficiently large scale to justify its existence. The simplest type of a manufacturing venture would be for one man to make the material, assuming it could be done on a one man scale. The amount of business would have to be sufficiently large to pay this man for his time and efforts and such pay, as well as all other charges, must come out of the price of the material. This becomes increasingly significant in the case of larger organizations.

It is not always an easy task to convince directors of corporations that they are justified in authorizing considerable expense for development which will of necessity be gradual. A new discovery in the insecticide world is not immediately adopted. In fact, entomologists have so much work to do, and it is so specialized, that they are not always able to keep fully informed as regards the new developments in their own profession. And if this is true, how less likely is it that dealers will purchase the new material—and the local dealer is often the overlooked limiting factor in the use of an insecticide.

The manufacturer must make a profit. Otherwise he ceases to exist. He must make a profit sufficient to overcome not only the manufacturing difficulties but expenses attendant upon selling and distributing his product. After the manufacturer comes the first purchaser; if there is a distributor he receives a profit; the jobber receives a larger profit and the retail dealer the largest of all. Retail dealers as a class do not like to handle agricultural insecticides for less than a 20% profit. All of these items must be included in the price of the prospective insecticide.

Finally, having estimated the probable price to the consumer of the new insecticide compared with the old one, under similar conditions as to the quantity, season, method of distribution, etc. Other queries arise. Will entomologists acquaint themselves with it? Will the consumer buy it? How much money will it take for advertising and other educational work to interest the consumer? Will the dealer handle it, so that the consumer can purchase when he wants it? The expense of this type of work must also come out of the ultimate price.

These remarks are not to be interpreted in any way as discouraging the search for new insecticides. On the contrary, it is an effort to indicate some economic factors, consideration of which should assist in the logical development of new insecticides.

This discusssion will also help to explain why the entomologist's estimates of the probable ultimate cost of a new product almost always falls far below the final cost to the consumer of the manufactured article. It may also put to final rest that old school suspicion that all insecticide

manufacturers are endeavoring to obtain unreasonable profits in the sale of their products.

The economic entomologist must be constructive and these remarks should include economic suggestions in answer to the universal inquiry "How can we get cheaper insecticides?" In partial reply the following are suggested:

1. Avoid the too frequent tendency to give the fewest methods of control. Give *all* the methods where feasible, explaining the limitations of each, so that the grower may choose for himself what, under his conditions, he considers most economical. This suggestion is intended also to give a grower other alternatives when he cannot, for one reason or another—sometimes very trivial, yet cogent—follow the best method of control. A method of partial control, if profitable, is more desirable than no control.

Include methods of farm manufacture but not to the exclusion of the factory made chemicals. As between farm manufacture and the factory made article on the one hand and the choice of a number of methods of control on the other, a status of competition may be fostered, and this is the powerful economic regulator of prices.

2. Promote group purchasing where practical. This does not necessarily imply displacing the local dealer by formation of growers' purchasing organizations. The local dealer may be in better condition to supply requirements than an organization that may be lacking in merchandising experience. The advantage in purchasing large quantities applies to purchases from the local dealer as well as purchases that would contemplate supplies direct from the manufacturer.

3. Promote the taking of cash discounts and building up of good credit standing. Where the grower has not the available funds himself, arrangements can often be made through the agency of a bank on a basis where both the bank and the grower receive benefits of the discount.

4. Promote early and off-season purchases. An order can frequently just as well be placed six months ahead of time for delivery at the growers' convenience as the present uneconomic method of waiting almost to the last minute before ordering—and paying sometimes dearly for that privilege.

Vice-President Fracker assumed the chair.

Vice-President S. B. Fracker: The next paper is to be read by Mr. S. C. Chandler.

SOME RECENT DEVELOPMENTS IN THE USE OF PARADICHLOROBENZENE

By S. C. CHANDLER, *Illinois State Natural History Survey*

ABSTRACT

Experiments and observations on the peach borer, *Aegeria exitiosa* Say, in Illinois during the past four years have brought out the following facts about paradichlorobenzene.* 1. Grass and weeds need not be removed from around the base of the tree before applying the chemical. 2. Heavy rains just before or just after treatment do not appear to effect the action of the gas. 3. One year trees have not been injured when treated with P. D. B., in the proper manner. 4. It is not necessary to remove dirt from around the trees after treatment. 5. Up to the present time, there have been no injurious cumulative effects of P. D. B., in Illinois. 6. P. D. B., packed closely against the bark of young peach trees will kill a large percentage of the trees. 7. No injury was produced by P. D. B., in experiment with apple trees. 8. 2 oz. application per tree is suggested as advisable for 12 year old trees.

As a result of four years of experimental work and observation in southern Illinois, some new and interesting conclusions have been reached on the use of paradichlorobenzene[1].

REMOVAL OF GRASS AND WEEDS

The common practice of scraping away grass and weeds from around the bases of peach trees before treating with P. D. B., is open to two objections, viz., it takes too much time, and there is a tendency to scrape away so much dirt that the chemical is applied below the point where some of the borers are feeding. This latter point is brought out in Table 1, which shows only 64% kill where applied too low.

Experiments to determine the necessity of removing grass and weeds before applying P. D. B., were begun in a small way in the fall of 1922, and followed up in the spring and fall of 1923. Trees 5 years old were selected for this purpose, in uncultivated and uncared for orchards in order to secure an excessive amount of grass and weeds, more than would usually be encountered.

By referring to Table 1, it will be observed that in 4 out of 5 trials during the three seasons in which the experiments were carried on, as good results were obtained where grass and weeds were not removed as where removed. The percentages of kill varied from 92% to 100% where not removed, and 79% to 100% where removed. In the course of these experiments a fact was brought out that I have observed every year in experimental work with this material, that worms killed by the

[1]Paradichlorobenzene, for convenience sake, has been called P. D. B., (Painless Death to Borers).

gas decay rapidly, and if treatments are left for from 4 to 6 weeks before examinations are made, few dead worms are found, though live larvae are usually easily located. To be conservative, however, I have not based my percentages of kill on the number in the check trees.

TABLE 1. A COMPARISON OF THE RESULTS OF P. D. B. TREATMENT ON PEACH TREES FROM WHICH GRASS, WEEDS, AND GUM HAD BEEN REMOVED PRIOR TO APPLICATION, WITH TREES IN WHICH THIS WAS NOT DONE.

Treatment Applied	Examined	No. of trees	Removed Live	Removed Dead	% kill	Not removed Live	Not removed Dead	% kill
Oct. 12, '22	Nov. 13	6	0	2	100	0	3	100
Check	" 21	6				7	0	
May 23, '23	June 18	10	3	12	80	3	18	85.7
Check	" "	5				9	0	
Sept. 15, '23	Oct. 20-22	10	0	4	100	1	5	83.3
Oct. 1, "	Oct. 22	10	2	17	89.4	1	13	92.8
" 13, "	" 27	10	13	51	79.6	1	12	92.3
" " "	" "	10	5	9	64.2[1]			
Check	" 22	10				28	0	

[1]Dirt removed such that P. D. B. was applied at level lower than some of the burrows.

EFFECT OF RAINS

As the killing agent in P. D. B., is a gas which penetrates to the burrows thru the air spaces in the soil, it would be reasonable to expect that rains filling these air spaces would retard or prevent the passage of the gas, and that it would be useless to treat immediately after soaking rains; also that a treatment applied just before a period of heavy precipitation would not be very effective. To spread some light on the question, weather records were examined in connection with the experimental work of the past four years, and data compiled which is presented in Table II.

These data show eleven cases in which rainy periods of from 4 to 11 days, with precipitations averaging 3.19 inches, immediately preceded or followed treatments which gave kills of 77% to 85% in the springs, and 80% to 100% in the falls.

YOUNG TREES NOT INJURED

The first experimenter with P. D. B., advised against its use on trees younger than 6 years of age. Other workers in Eastern states have reported injury on young trees. Following these men, a number of writers have included in their recommendations the caution not to treat young trees.

Table II. Effect of Rains

Date of Application	Place	Rainfall In.	Period of Rainfall	% Kill
May 15, 1920	Carbondale	3.97	May 16–21, six consecutive days of rain	77%[1]
Sept. 1, 1920	"	1.23	Aug. 26–31, 4 days rain out of 6	100%
Sept. 16, 1920	Farina	3.52	Sept. 8–15, 8 day period, with 7 days of rain	100%
May 2, 1921	Anna	2.71	Apr. 26–May 2, 7 day period, with 5 days of rain	100%
Sept. 28, 1921	Ozark	3.82	Sept. 24–27, 4 consecutive days rain	100% Lot 1 100% " 2
Sept. 12, 1921	Anna	2.09	Sept. 1–11, 11 day period, 9 days of rain	100%
Oct. 12, 1922	Carbondale	2.92	Oct. 6–11, 6 consecutive days of rain	100% Lot 1 100% " 2
May 23, 1923	Ozark	4.27	May 12–19, 8 day period, with 7 days rain, then 3 days intermission, then	80% Lot 1 85% " 2
		1.05	May 23–31, 8 consecutive days	
Sept. 1, 1923	Carbondale	3.01	Sept. 1–7, 7 day period, 6 days of rain	100%
Oct. 13, 1923	"	5.57	Oct. 16–19, 4 consecutive days, following 2 dry days	80% Lot 1 92% " 2

[1]Compared with 78% in dry period two weeks before.

Realizing that if this new material was to be of much value to the growers, it must be used on trees younger than 6 years old, we begun in the spring of 1920, with much trepedation, to treat 5 year trees. At first it was thought that some little injury resulted, as small, somewhat circular brown areas were found where the chemical might have affected the bark, but these areas were also found on untreated trees, both at that time, and every year since. Finding no apparent injury to 5 year trees, we moved our experiments in the fall of 1920 to 2, 3, and 4 year orchards, with equally good results. For the next two years, both fall and spring we treated 1 year trees, in no case causing injury. We usually used ¾ oz., per tree, but in two different orchards applied doses of 1½ oz., to blocks of 10, 1 year trees, with no ill effects.

Beside this experimental evidence, we have many acres of one year peach trees in Illinois which have been treated by the orchardists with no reports of injury.

The fact that young trees have not been injured in Illinois may be due

to climate or soil. There are two main types of soil in southern Illinois on which most of our orchards are located, the loess soils of the unglaciated hill lands, and the gray silt loam of the glaciated prairies.

Removal of Dirt From Bases of Treated Trees

In going over the recommendations for the use of P. D. B., I find it quite commonly advised to remove the dirt from around the bases of treated trees, after a period of from 10 to 14 days. To determine the necessity of this procedure we left undisturbed until spring a part of the trees treated in our first fall's experimental work in 1920. These trees

Fig. 7.—Peach tree ready for application of P. D. B. Grass and weeds not removed prior to treatment.

appeared to be just as healthy the following season as those examined the fall before. The caution to remove the dirt was not included in our recommendations, and as a result this has very rarely been done in Illinois. We have, it is estimated, two million peach trees in the commercial orchards of the State. At least a million of these have been treated, at some time, with P. D. B., and I have yet to hear of a case in which the dirt was removed. This includes such orchards as those listed in Table III, which have been treated for 3 and 4 consecutive years.

Cumulative Effects of P. D. B.

Altho we have no authentic record in Illinois of injury to peach trees from P. D. B., where applied in the proper manner, the question arises as to whether we can continue to use it year after year with no ill effects. Some data bearing on this point are given in Table III. This shows a total of 200 acres treated for 4 successive years and 115½ acres for 3 successive years, all with no ill effects. Ages of trees when treatment was first begun ranged from 1 to 10 years. The record of effect on trees was secured both from personal observation and talks with the owners.

Table III. Cumulative Effects of P. D. B.

Orchard	Place	Present Age—Yrs.	No. acres	Yrs. Treated	Effect on Trees
Amer. Fruit Growers	Cobden	3–12	200	4	No ill effects.
Paul Miller	Anna	5–7	50	3	" " "
J. C. Hundley	Carbondale	3	10½	3	" " "
John A. Gage	Texico	7	5	3	" " "
Guy Beauman	Tunnel Hill	7	50	3	" " "

The Effect of P. D. B. Touching the Bark

Users of P. D. B., have generally been cautioned against allowing the material to touch the bark of peach trees. In my own experimental work I have observed no injury when a few crystals have come into contact with the bark. To determine this point, four 1-yr. old trees were treated at Anna, in May 1922, using ¾ oz., per tree, packing it close against the bark. In July, these 4 trees were apparently as healthy as the other treated trees, but in September one was seen to be dying, and a dead area was found around the base of the trunk. At that time seven 1-yr. trees were treated in a similar manner at Ozark, Ill. In March, 1923, 6 of the 7 were observed to be dead at the base, tho the tops were still green. One of the seven was accidentally removed during the summer, but on September 12, the date of my last examination, 5 of the 6 were entirely dead, tho trees of the same age treated in the regular manner, were uninjured.

P. D. B. on Apple

To the writers knowledge the only experimental work on the use of P. D. B., on apple, (the results of which have been published) was carried on by E. B. Blakeslee in Springfield, W. Va., and recorded in U. S. D. A., Bul. 796. In this experiment 12 three year old apple trees

were treated, and all severely injured. Most of the smaller larvae of *Saperda candida* were killed, but the more mature specimens, working in the burrows, were still living.

In September, 1921, I treated six 8-yr. old Transparent apple trees at Ozark, Ill., with ¾ oz., P. D. B. A month later these trees were examined. A total of 7 live borers and 7 dead were found. As in the case above referred to, the live borers were usually those deepest in the wood, and especially those that had worked highest up. No injury, however, was observed, either at that time or later. This may possibly indicate that injury to apples by P. D. B., under conditions of soil and climate similar to those of southern Illinois, may not be feared, and it is recorded here in the hope that it may be of some help to future investigators of the subject.

Amounts to be Used on Old Trees

Our usual recommendation has been to use ¾ oz., for trees from one to five years of age, and I oz., for trees six years old or older. To ascertain the amounts needed on old trees, a portion of a 12 year old orchard was treated in Centralia, on Oct. 19, 1922, using 1 oz., 1½ oz., and 2 oz., respectively, with the following results:

10 trees,	1 oz.	totalled	27	worms,	23	dead,	or 85.5%	kill.
10 "	1½ "	"	52	"	47	"	" 90.4%	"
10 "	2 "	"	60	"	59	"	" 98.4%	"
10 "	Check	"	101	"	0	"	"	

These data, altho from but one season's work, indicate that it might be profitable to apply as much as 2 oz., of P. D. B., to trees of this age.

Mr. Alvah Peterson: I would like to ask Mr. Chandler if he has had any experience in treating peach trees in the nursery with this material.

Mr. S. C. Chandler: We have only tried it in the case of one or two trees.

Mr. J. J. Davis: I might say that we have used Paradichlorobenzene on nursery stock with apparently satisfactory results.

While I am on my feet, I wish to report the experiments which we conducted in Indiana in 1921 and 1922. We have been able to get just as good control in heavy sod as on bare ground, in the lightest sand soils and in the heaviest clay soils, and from the entire south and to the extreme north end of the state. Satisfactory results have been obtained both in our experimental plots and in a large number of commercial

orchards—in fact, I have yet to hear of any injury where the material was used in commercial peach orchards, even one year old orchards.

I understand some injury resulted from the use of Paradichlorobenzene last fall in other sections of the country, rather extensive injuries, but the conditions were entirely different from what we would ever expect to have in Indiana, and I do not believe that these experiments should deter us, in the central west, from following our present recommendations.

Mr. W. E. Britton: I would like to inquire if this material is not covered?

Mr. S. C. Chandler: Yes, we cover it.

Mr. W. E. Britton: It seems to me the chief diffiiculty would be in covering it where you do not remove the weeds.

Mr. S. C. Chandler: We have had no trouble of this kind. I picked out an orchard especially grassy and weedy, more than we expected to find in a commercial orchard, and we had no difficulty in handling the material.

Mr. Alvah Peterson: In New Jersey, in treating about 250 nursery trees we killed 75 per cent of the trees with one-fourth ounce per tree. On two year old trees in some orchards, we have found considerable injury. However, there are many growers in the state of New Jersey who are at the present time using one-fourth ounce per tree on trees one year old, and three-eighths to half an ounce on two year old trees.

During 1923 we also saw injury in an 8 year old orchard, which we believe was due to paradichlorobenzene. This orchard was weakened at one time by frost injury, and it was also severely infested. The grower, for the first time, last fall (1922) treated that orchard with paradichlorobenzene, and 25 per cent of the trees were dead at the first of September of this year (1923).

Mr. F. H. Lathrop: I was wondering whether any one has done any work with the actual concentration of the gas. Even if a two year old, or a one year old tree is given, say one-quarter of an ounce of the material, the actual concentration in the gas may be much greater than one ounce on a tree four to six inches in diameter, so we are really giving it a heavier dose of the material—that is, considering it on the basis of the concentration of the gas. I was wondering whether any work has been done along the line of determining the concentration of the gas that the trees can stand?

Mr. S. C. Chandler: I do not think any work has been done along that line.

MR. J. J. DAVIS: I would like to ask Mr. Peterson the season he got injury to nursery stock?

MR. ALVAH PETERSON: We carried out experiments for two years. Some applications were put on in May, and other applications were put on in September, and we ran experiments all the way from four days up to indefinite exposures.

MR. S. C. CHANDLER: May I ask the type of soil?

MR. ALVAH PETERSON: This happened to be a heavy, Penn loam soil, and in another nursery it was a sandy loam soil.

VICE-PRESIDENT S. B. FRACKER: The next paper is by O. I. Snapp.

THREE YEARS OF PARADICHLOROBENZENE EXPERIMENTS IN THE SOUTH

By OLIVER I. SNAPP, *Entomologist, U. S. Bureau of Entomology, Fort Valley, Ga.*

ABSTRACT

Paradichlorobenzene treatment of peach trees for control of the peach borer, *Aegeria exitiosa* Say, has become an annual practice in the program of orchard management in Georgia. Five hundred thousand pounds of the material were used in the Southeast during the 1923 season. The results of experiments indicate that under normal conditions the large doses exposed for short periods are not as effective as the smaller doses exposed for four to six weeks. No tree injury resulted from the use of the various doses around three, four and five year old peach trees in Georgia during 1921 and 1922 when normal weather conditions prevailed. However, during the 1923 season a precipitation deficiency occurred accompanied by abnormally high temperatures. These unusual weather conditions caused rapid action from the gas, and as a result some rather severe injury has shown up on three year old trees from the use of the ¾ and one ounce dose. During each of the three years no injury has resulted from the use of the ¾ ounce dose around four and five year old trees for twenty eight days. One and two year old trees have shown, each year, more or less injury from the use of the ½ and ¾ ounce dose. To date no injury has been revealed from allowing the mounds to remain around the trees over winter. Late October and November applications of paradichlorobenzene gave a control of around seventy-five per cent. December applications were worthless. Applications made around April 1st in Georgia gave about seventy per cent control. Laboratory experiments show that the gas is liberated at about the same rate in both sandy loam and clay soils. Tests in the laboratory have repeatedly shown that the higher the moisture content of the soil and the lower the temperature, the slower is the action of the gason the borer.

The use of paradichlorobenzene in the South for control of the peach borer (*Aegeria exitiosa* Say) has rapidly increased in popularity during the last three years. A large percentage of the peach growers in Georgia have now adopted the treatment, and the use of the chemical in that state has become an annual practice in the program of orchard manage-

ment. During the 1921 season a quarter of a million pounds of paradichlorobenzene were used for borer control by the peach growers in the Southeastern States. During the following season (1922) about the same amount was used. Reports, however, show that during the fall of 1923, five hundred thousand pounds of the material were used in the Southeast. These figures are indicative of the increased interest in this new method of borer control, and of the satisfactory results that have been obtained from its utilization in commercial peach orchards.

Blakeslee's work prior to 1920 showed that the chemical could be safely used on trees six years of age and older for the control of the peach borer. In certain cases, however, he noticed injury to trees younger than six years of age that were treated with paradichlorobenzene. In view of the fact that the peach borer is often very destructive in young orchards, and since it would be highly desirable, if possible to use the chemical on peach trees of all ages, extensive experiments have been conducted in Georgia by the Bureau of Entomology during the last three years to ascertain whether the new method of borer control could be extended to trees of all ages under climatic conditions in that latitude. For these experiments peach trees ranging from one to five years of age were used. Studies were also made of the effect on the trees from not opening up the mounds and removing unspent crystals six weeks after the application. The effectiveness of late fall, early winter, and spring applications of paradichlorobenzene were tested in another series of experiments. The laboratory work included a study of the effect of temperature and moisture on the rate of evaporation of paradichlorobenzene and what influence these factors have on the mortality of the peach borer from the toxic gas.

No attempt will be made in this paper to give detailed accounts of the results obtained from any of the work. An effort will be made to merely point out the most important things revealed as a result of the work, and to report on the action of the chemical during a season when a precipitation deficiency is accompanied by abnormally high temperatures. (I wish to give due credit to Mr. C. H. Alden of the U. S. Bureau of Entomology who has assisted the writer with all of the paradichlorobenzene work in Georgia during the last three years.)

Results from the Use of Paradichlorobenzene on Young Peach Trees

During the past three years several thousand peach trees ranging from one to five years of age have been treated with both small doses of

paradichlorobenzene for long exposures and large doses for short exposures. For the long exposure tests one-half, three-fourths and one ounce doses were allowed to remain around the trees for periods of three, four and six weeks, and also over winter. For the short exposure tests, one and a half, two, and two and a half ounce doses were exposed to the trees for periods of four, eight and twelve days.

The results of these experiments indicate that under normal conditions the large doses exposed for short periods are not as effective as the smaller doses exposed for four to six weeks. The three-fourths ounce dose as well as the one ounce dose gave almost perfect control of the borer when exposed to young peach trees for four weeks. In nearly every case the control was one hundred per cent. The control from the one-half ounce dose averaged about 87.5 per cent. The control from large doses exposed for four, eight or twelve days varied between fifty-five and ninety per cent.

Three separate examinations for tree injury from the various treatments were made on all the trees. The first was made about six weeks after the application, the second during the following spring, and the final one during mid-summer of the following year. No injury resulted from the use of the various doses around three, four and five year old trees during 1921 and 1922 when normal weather conditions prevailed in Georgia. However, during the fall of 1923 very abnormal weather conditions occurred in central Georgia, causing rapid action from the paradichlorobenzene crystals and an unusual resultant effect on young peach trees, which should be of special interest to those engaged in paradichlorobenzene investigations elsewhere.

Paradichlorobenzene is placed around peach trees in Central Georgia between October 10 and 15. During the month of September 1923 a precipitation deficiency occurred which caused the soil to be exceedingly dry when the material was put out in October. During the three weeks following the application, practically no rainfall occurred. A local weather station six miles from where the paradichlorobenzene experiments were conducted reported only a trace of rainfall for the entire month of October 1923, which was the smallest amount recorded for any October at that point during the last 32 years. The normal October precipitation in Central Georgia is about three inches. Therefore, a drought occurred before the paradichlorobenzene was applied in 1923, and continued for three weeks following the application.

The soil temperature during October 1923 was abnormally high in Central Georgia. The mean soil temperature from sun rise to sun set

during the three weeks in October following the paradichlorobenzene application was 70.5°. The mean soil temperature for the same period in 1922 was 64.9°, and for the same period in 1921 was 63.2°. Soil temperatures were not taken in Central Georgia prior to 1921, but by comparing the October 1921, 1922 and 1923 mean sun rise to sun set soil temperatures with the mean air temperatures for the same period and then with the mean air temperatures for October during the last 32 years, the normal mean sun rise to sun set soil temperature for October was found to be about 65°. Therefore, the mean soil temperature during October 1923 in Central Georgia was at least 5 degrees above normal.

Moisture and temperature greatly influence the rate of evaporation of paradichlorobenzene crystals. The dryer the soil and the higher the soil temperature the more rapid is the generation of paradichlorobenzene gas from the crystals. Little, if any, gas is given off when the soil temperature is below 60° F. A study of the October 1923 climatological data for Central Georgia to which I have referred above, revealed the fact that the weather conditions were very unusual, and were favorable for an exceedingly rapid generation of paradichlorobenzene gas.

Upon examining the young peach tree four weeks after the application for borer mortality and tree injury, the crystals had entirely disappeared in most cases, which was unusual, and the condition of the dead larvae caused us to conclude that the rapidity of the action from paradichlorobenzene had been so great during the fall of 1923 that borer mortality resulted within two weeks.

The rapid action from the gas last October brought about by the unusual weather conditions, caused more or less injury to young peach trees. Rather severe injury resulted to some of the three year old trees from the use of the ¾ and one ounce dose. The extent of this injury cannot be definitely determined until next spring or summer, however, at the present time some severe cambium injury has been discerned. During the three years that the experiments have been under way (including 1923) no injury has resulted from the use of the ¾ ounce dose around four and five year old peach trees for twenty eight days. Under the weather conditions in Central Georgia during October 1923 the one ounce dose caused some flecking of the bark layers of four and five year old trees, and in a few cases the six weeks exposure of the one ounce dose caused some cambium injury to trees of those ages.

One and two year old trees have shown, during each of the three

years, more or less flecking of the bark layers or cambium injury from the use of the ½ and ¾ ounce dose.

Effects from Allowing Paradichlorobenzene to Remain Around the Trees All Winter

Each year a hundred, or more, trees five years of age, or older, were treated with one ounce doses of paradichlorobenzene in the fall and the mounds left up around the trees over winter to note the effects from allowing the crystals to remain around the older trees all winter.

Examination of these trees made during the spring and again in July of 1922 and 1923 showed no tree or trunk injury from allowing the mounds to remain around the trees over winter. Some injury may be revealed during the spring or summer of 1924 from allowing the mounds to remain around the trees in Georgia during the present winter, on account of the abnormal weather conditions that occurred there last fall.

Results from Late Fall, Early Winter, and Spring Applications

The effectiveness of late fall, early winter, and spring applications of paradichlorobenzene was tested on trees five years of age, or older, in another series of experiments. A different group of trees was treated with the one ounce dose every other week from the middle of October until the middle of December, and examinations for effectiveness made during the following May. To determine the effectiveness of the spring applications a number of trees was treated with the one ounce dose about April 1st and examined for borer control during the middle of May.

These experiments showed that the applications made during the latter part of October and during November in Georgia gave a control of around seventy-five per cent. December applications in Georgia were worthless as no borer mortality resulted from the applications placed during that month on account of the low soil temperature. Paradichlorobenzene applied to trees in the spring around April 1st in Georgia resulted in about a seventy per cent control.

Paradichlorobenzene for peach borer control gives the best results when used at the close of the oviposition period of the adult. Life history studied of the peach borer in Middle Georgia show that maximum emergence of adult moths takes place in middle September and the last of them are on wing during the latter part of that month. Allowing five days for the oviposition period of the last females, and a maximum

of ten days for the incubation period at that time of the year, paradichlorobenzene applied between October 10–15 in Middle Georgia finds all larvae hatched, and since they are small and in shallow galleries a control of from ninety-eight to one hundred per cent results provided the material is applied strictly according to directions. For best results in the Northern or Southern part of the State the dates should vary about five days from those found to be most satisfactory for the Central Section.

Late October and November treatments may give fair results. However, if the late fall should happen to be abnormally cold very poor control would result. An effort should be made to apply the material shortly after the oviposition period of the insect, so that sufficient action from the crystals may be had before the soil temperature becomes too cold for the proper generation of the gas.

Spring applications are not as effective as the early fall applications on account of the size of the larvae in the spring and the fact that many individuals are in deep galleries by that time. The larger the borers and the deeper they are in the galleries, the more difficult it is to kill them with paradichlorobenzene gas. Spring applications cannot take the place of the early fall treatments, and should only be used where for an unavoidable reason the grower was not able to apply the material in the fall. Aside from poorer results with spring applications they permit the borers to work in the trees unmolested until many are nearly full grown.

Experiments with Paradichlorobenzene at Room Temfreatures

Many experiments were conducted in the laboratory during the three years that the field experiments have been under way, including studies on the rate of evaporation of paradichlorobenzene under ordinary room conditions, mortality of peach borer larvae exposed to paradichlorobenzene, and the influence of temperature and moisture on the effectiveness of the material.

The rate of evaporation around peach trees in an orchard is much faster than it would be at room temperature—the latter temperature being lower. From ninety-one to one hundred and thirty-five days were required for the evaporation of one-half ounce doses of paradichlorobenzene in the laboratory imbedded from four to six inches below the soil surface. One-half ounce doses placed on the soil surface evaporated in sixteen days. Therefore, the soil mounded on top of the crystals around peach trees to prevent surface washing and to serve as a con-

tainer for the gas should not be deep, as the deeper the crystals from the top of the soil the slower will be the generation of the gas.

Laboratory experiments continually show that the gas is liberated at about the same rate in both sandy and loam clay soils. Under ordinary room conditions paradichlorobenzene gas killed all larvae as far down as one foot below the soil level within a period of three weeks. Tests in the laboratory have also repeatedly shown that the higher the moisture content of the soil and the lower the temperature, the slower is the action of the gas on the borer. A detailed account of the results obtained from the first year's work with paradichlorobenzene in Georgia will be found in Department Bulletin 1169, which was recently issued as a report of progress.

VICE-PRESIDENT S. B. FRACKER: The next paper is by T. L. Guyton.

ORIENTAL FRUIT MOTH IN PENNSYLVANIA IN 1923

BY T. L. GUYTON, *Pennsylvania Department of Agriculture, Harrisburg*

During the season of 1923 the Oriental Fruit Moth (*Laspeyresia molesta* Busck) caused a heavy loss to fruit growers in the southeastern corner of Pennsylvania. Reports show the insect to have been present before 1923, but not numerous enough to cause commercial loss.

In 1921 the Bureau of Plant Industry made a survey of two of the counties now heavily infested, and in none of the several peach orchards examined was the presence of the moth suspected. One report in 1922 showed the moth to have been established at one point. No doubt the moth was present in many other places, but no out-standing damage was noted.

In 1923 estimated losses varied thruout the area of infestation. One peach grower reports a loss of seventy-five percent of his crop, or about twenty carloads. His was the heaviest loss reported. Nearly all other reports gave about twenty percent as the loss. Quince fruits found in the infested area were entirely destroyed. This fruit is a favorite food of the larvae.

Only a fragment of the life history of the moth was observed. A definite brood of adults was evident the last week of August. These moths produced the brood of larvae which caused the heavy loss to Elberta peaches. It was difficult to find larvae about peach trees on October first, but quinces contained many larvae, and several larvae were found in cocoons about the quince trees. Active larvae were found in fallen quinces as late as November fifth.

The exact area of infestation in Pennsylvania is not definitely known. It is evident that the shipment of ripe peaches from infested areas has done much this year to extend the range of the pest. It is known to be present only in the southeastern quarter of the state at this time.

VICE-PRESIDENT S. B. FRACKER: The next paper is by Mr. W. P. Flint.

A NEW APPLE PEST, METACHROMA INTERRUPTUM

By W. P. FLINT, *Urbana, Ill.*

Occasionally we encounter some native insect that is acquiring a taste for cultivated crops in preference to its natural food. This appears to be the case of the feeding on apple and peach by the willow beetle, *Metachroma interruptum* Lec.

During the summer of 1921, several lots of apples were sent to the Experiment Station at Urbana showing a type of injury different from that known to be caused by any of the insects which commonly feed on this fruit in Illinois. In 1922, apples showing this same type of injury were received from nearly all the orchard sections of the State and a few orchardists reported 5 to 10% of the fruit in their orchards had been damaged.

A search of these orchards during the day in an attempt to find the insect causing this injury was unsuccessful. An examination at night however ,showed hundreds of small brown beetles crawling about over the foliage and feeding on the fruit. The beetles were first found during the last week of June but had been feeding before this. They had all disappeared by July 4, 1922. The insect was identified by Doctor C. P. Alexander and W. S. Blatchley as *Metachroma interruptum*, family Chrysomelidae. It is supposed to be a western species feeding on the willow and to occur but rarely in Illinois and Indiana. Correspondence with the entomologists in the group of states lying west of the Mississippi has shown that *Metachroma interruptum* is fairly common in South Dakota and Kansas, but there are no records of its feeding on fruits.

In 1923, an attempt was made by Mr. J. H. Bigger of the State Natural History Survey to work out the life history of the insect. Owing to pressing calls for assistance in chinch-bug control, this work was not completed. A few additional facts were gathered concerning the habits of the adult beetles. The spring this season was cool and most of the common insects did not appear as early as usual. Metachroma was not found feeding on the apples until the last week in June

and continued up to about July 20. Beetles were found mating each night, examinations were made during this period. The beetles fly to the apple trees just as it is becoming dark and it was impossible to trace their flight. They remained on the trees at least until midnight. Usually one or two would be found on a fruit, sometimes as many as six. No feeding was noted on the foliage of the trees in the orchard, but the beetles fed on the leaves of apple when confined in cages. Careful search during the day of the soil and usual insect hiding places in the vicinity of the orchard disclosed one beetle under the bark of a tree and one in the leaf mulch under the trees.

Cage experiments showed the beetles were not killed by the strengths of arsenate of lead used for control of codling moth, that is, one pound to fifty gallons of water, and were repelled by this poison, but would feed on the sprayed foliage after twenty-four hours when no other food was offered. Three and four pounds of lead to fifty gallons of water killed the beetles in cages after about forty-eight hours.

Extent and Character of Injuries

The injury by this insect, so far as noted, is caused entirely by the feeding of the beetles on the surface of the fruit. Even a small amount of feeding rendering the fruit unfit for first grade and in most cases reduces it to cider stock.

During 1921, the injury was slight, in 1922, the crop in some orchards was damaged 2 to 10%, in 1923, the damage was less varying from scattered feeding on single apples to 5% injured fruit in at least one orchard. Even in 1923, damage on individual trees would run to 75% of the fruit. Injury to apples was also reported by J. J. Davis and Doctor Bennet A. Porter from points in south western Indiana.

During 1923, the characteristic injury by this beetle was noticed on the peaches in several orchards in the southern part of the State and in one peach orchard the damage was severe on the outer rows.

Mr. Arthur Gibson: I would like to ask about the occurrence of this insect.

Mr. W. P. Flint: The insect is common in Indiana and Illinois. It has also been found in Kansas and Nebraska. It is apparently not common west of the Mississippi river.

Mr. E. P. Felt: It may interest those present to know that in New York State in recent years we have had very similar injuries on apples,

although not nearly so severe, by a closely related species, *Nodonota puncticollis* Say.

VICE-PRESIDENT S. B. FRACKER: The next paper is by S. W. Frost and E. M. Craighead.

DUSTING FOR LEAF-HOPPERS (*EMPOA ROSAE* L.) IN BEARING APPLE ORCHARDS

By S. W. FROST, and E. M. CRAIGHEAD

ABSTRACT

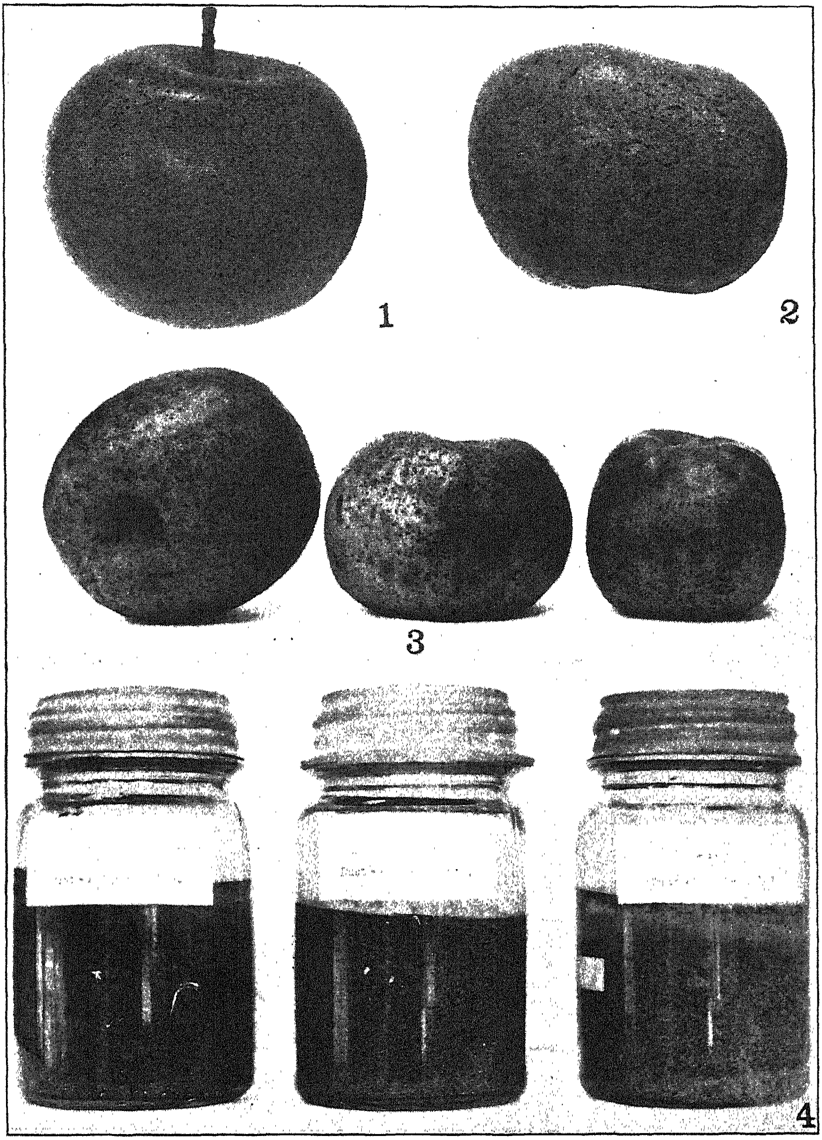
This paper open a new field in entomology, that of controlling leaf-hoppers (*Empoa rosae* L.), in bearing orchards. The seriousness of the pest and a new type of the injury is described. Field tests show that the nymphs and adults can readily be killed by nicotine dusts.

The leaf-hoppers (*Empoa rosae* L.) have become a serious pest on bearing apple trees throughout Pennsylvania. During the past five years they have increased gradually in numbers and now, without doubt, can be classed among the most serious insect pests of the apple. During the summer of 1923 they were exceedingly abundant in well-cared-for orchards where no nicotine dust or spray was used during the summer. Their abundance demanded some immediate attention.

Heretofore the necessity for special applications of spray or dust to control leaf-hoppers on bearing apple trees, has not appeared to be very urgent during normal seasons. Due to the fact that little or no data have been secured upon the practical value of spraying or dusting in bearing orchards, the writers have deemed it expedient to try some dusting experiments. This really opens a new field in economic entomology.

NATURE OF THE INJURY

The most serious injury is, no doubt, inflicted upon the foliage, although serious damage is sometimes done to the fruit. The leaf-hoppers suck the sap from the leaves, removing the chlorophyll and causing them to turn white in color. The leaf-hoppers suck out the contents of whole cells while the red-spiders puncture individual cells, removing only part of their contents. This accounts for the difference in appearance of two similar kinds of injury. Leaf-hopper injury, together with red-spider and scab injury often render the foliage almost functionless. Premature dropping of the foliage and the fruit takes place as the result of such injuries. No doubt a material reduction in the size of the fruit results in case of serious injury of this kind. No data, however, have been secured to indicate this.



1, Fruit spotted by liquid discharge from nymph; 2, 3, leaf-hopper scars on York imperial; 4, Pint jars showing leaf-hopper population from three different trees. These leaf hoppers were brought down by nicotine dusts.

During the summer of 1923, many orchardists suffered serious losses through the spotting of the fruit by the liquid discharged by the hoppers. The spotting was so abundant in some orchards as to seriously mar the quality of the fruit. Rains during the latter part of the summer washed these spots forming sooty streaks and ruining the appearance of a large percentage of the fruit.

A new and serious type of injury was also noted on the fruit. The nymphs puncture the fruit with their beaks. Later in the season these punctures crack open giving the fruit a mottled or russeted appearance. This type of injury was particularly noticeable on york imperial, stayman winesap, grimes golden and pound apples. On the stayman the scars were usually triangular in shape probably having their origin in the lenticles. On the yorks the scars were rod shaped often resembling a fruit injured by rubbing against a limb.

Control Measures

During the past season, some preliminary control measures were taken. Nicotine dusts were applied during the month of June with encouraging results. The dusting was done on the twelfth and fourteenth of June. This was a trifle too late as nearly one third of the nymphs had transformed to adults. A dust two weeks earlier would have yielded better results. The afternoon was selected for the work. At that time the air was warm and dry and there was little wind. It was found necessary to select ideal conditions for the dusting work. Under these conditions a high percentage of control was affected. When the air currents were strong it was found impossible to maintain an atmosphere of nicotine dust about the tree long enough to give satisfactory results. The work was done with one of the latest types of dusting machines. Two types of dust were used; a 2% nicotine sulphate dust with hydrated lime as a carrier and free nicotine dusts with clay as a carrier. The percentage of both nymphs and adults killed by the nicotine dusts ran exceedingly high.

In making the test, counts were made of the numbers of leaf-hoppers per leaf before and after dusting. These counts were taken from the inside as well as the outside of the tree and from the lower as well as the upper surface of the leaves. The first counts were made in the morning, the dusting was done shortly after noon and the second leaf-hopper counts were made a few hours after dusting.

Immediately after dusting a tree, the leaf-hoppers commenced to fall to the ground. In badly infested orchards they sounded like rain as

they fell upon the lower leaves of the tree. Heavy white muslin sheets were placed under the trees to catch the hoppers as they fell. They were so numerous that it was difficult to make counts. A few counts were made of the number of leaf-hoppers per square foot from which the number upon the sheet was estimated. They were so abundant that they could be measured by the pint. An average twelve year old tree with a medium infestation yielded about a half a pint of leaf-hoppers. Older trees yielded over a quart of leaf-hoppers

SUMMARY OF LEAF HOPPER COUNTS IN DUSTED PLATS, ARENDTSVILLE, Pa., 1923

Material	No. leaves examined	No. leaves free from L. hoppers	% free leaves	No. leaf-hoppers	No. leaf hoppers per leaf
	BEFORE DUSTING				
2% Nic. Sulphate, H. Lime	430	89	20.6	1219	2.8
1¼% Free Nicotine Dolomite	567	185	30.8	1035	1.8
2% Free Nicotine Dolomite	436	115	26.3	998	2.2
2% Free Nicotine Dolomite	654	198	30.2	913	1.3
2% Nic. Sulphate H. Lime	656	261	38.8	700	1.0
	AFTER DUSTING				
2% Nic. Sulphate, H. Lime	498	413	82.8	150	.30
1¼% Free Nicotine Dolomite	1266	1232	97.3	34	.02
2% Free Nicotine Dolomite	1227	1175	95.6	65	.05
2% Free Nicotine Dolomite	1485	1210	81.5	406	.26
2% Nic. Sulphate H. Lime	1749	1495	85.4	175	.10

Applications made on June 12th.

CONCLUSION

While we cannot say that dusting or spraying for leaf-hoppers in bearing orchards will be practical, because of the great abundance of these insects and the possibility of the orchard becoming reinfested from adjoining orchards, the great abundance of leaf-hoppers in Pennsylvania and their seriousness as a pest on apple, demands considerable attention. Nicotine dusts have given an excellent percentage of kill under favorable conditions. It still remains to be discovered whether one or two applications of nicotine dust during June will be sufficient to keep the hoppers under control. The cost of nicotine dust or spray would prohibit a larger number of applications.

VICE-PRESIDENT S. B. FRACKER: We will now listen to a paper by H. A. Gossard.

SHOULD THE MIDSUMMER APPLE SPRAY BE TIMED FOR THE SECOND BROOD ONLY OF CODLING WORM?

By H. A. Gossard

Abstract

Studies of the life history of the codling moth, *Carpocapsa pomonella*, have been made, partially or fairly complete, at Marietta in southern Ohio, at Wooster in the north central section and at Gypsum in the northwestern section. Records of the dates when the sprays are commonly applied have also been kept through a series of years. The stages of development of the moth at the dates of spraying are shown by the life history chart. The tentative conclusion is reached that when the season is late the summer spray should be earlier than usual instead of later and that a later second summer spray is desirable in such a year.

It is quite generally assumed by orchardists and entomologists that the July spray given to apples in Ohio and nearby states should be specially timed for the second brood of worms and if timed to work most havoc with this brood, it is likewise assumed that the results will be more acceptable than if the spray is given earlier or later than this pivotal date.

After a good many attempts to render this spray most effective by timing it according to data secured by rearing the moths in cages and from field observations, moth traps on the tree trunks, egg-laying records, etc., we raise the question if the best date can be determined by this method; or if we must supplement such data by experience data and settle upon a time that has given maximum results through a long period of years. Results are so frequently disappointing from the spray after all possible care has been taken to put it on after the moths have commenced to emerge and just when egg-laying has commenced, that it seems worth while to discover why a spray, so timed, sometimes gives a much more wormy harvest than sprays put on neighboring orchards at an earlier time, chosen on the basis of average experience.

Studying the life-history of *Carpocapsa pomonella* in relation to the dates when the midsummer spray is commonly applied in Ohio, as shown by records extending over several years, it appears that the explanation may lie in the overlapping of the broods of codling worm. As shown by the life-history chart the eggs of the spring brood are still hatching when the moths of the second brood commence to emerge and there is from 1 to 3 weeks overlapping of the larvae of the spring and summer broods. This overlapping comes in the month of July, six weeks or more after the last treatment for codling worm is given, following bloom, if the usual schedule is followed. If given a week earlier

than usual, the midsummer spray will effectively dispose of the first-brood worms then hatching, but may not be sufficiently lasting to kill all the worms of the summer brood, the late comers of which will be hatching 6 to 8 weeks later. If delayed till the second-brood eggs are hatching, all the late comers of the first-brood escape, and the grower has been obliged to do a good job of guessing just when to spray, or else he has had to spray sufficiently early to insure the destruction of the first-brood worms and to use adhesive sprays so copiously that the poison is carried on the fruit and leaves until well into September.

At Marietta, summer-brood moths begin to emerge in late June and egg-laying commences in some years about the 4th of July, but usually does not reach the climax till early in August. The midsummer spraying should, therefore, be done the first week in July or thereabouts in that locality, though in some seasons the moths do not appear numerously until after July 15. Experience suggests an earlier spray to give best control, and the dates used for spraying in Washington County vary from July 1 to July 15. The only possible explanation for this necessity is that a spray is needed at this time to destroy the late comers of first-brood worms, and that the poison will adhere long enough to kill the bulk of the summer-brood worms, even though most of them do not hatch until sometime in August. The midsummer spray is not so apt to be washed from the leaves and fruit by rains as the earlier sprays and, therefore, lasts over a longer period. There is, too, an accumulation of poison on the trees from the earlier treatments, making the poison cover thicker than it was immediately following the spring applications.

The midsummer spray is given at Wooster from July 20 to August 1. Observation of the results leads us to the conclusion that in the average season, July 20 is best. That the blooming was late is not a good cause for postponing the spray, but on the contrary seems to be a good reason for applying the spray early. In such a season the midsummer brood is not delayed so much as the spring brood, and in mid-July, the latter part of the spring brood is more damaging than usual. A supplementary spray the first week in August may be very desirable in such a year, but if this is not applied, apparently the rule should be, "Apply the midsummer spray early and very thoroughly if the season has been backward."

The progress made in this study has been stated in considerable detail in the Monthly Bulletin, Ohio Agricultural Experiment Station for May–June, 1923, pp. 73–78.

VICE-PRESIDENT S. B. FRACKER: A paper will now be presented by Mr. P. J. Parrott.

SOME SIDE LIGHTS ON SPRAY INJURIES TO APPLE FRUITS AND FOLIAGE

By P. J. PARROTT, *Geneva, N. Y.*

ABSTRACT

Because of the danger of injury to apple foliage and fruits from lime-sulfur, experiments were undertaken to determine the value of hydrated lime, calcium caseinate and glue in reducing the injurious properties of this spray as well as to ascertain the utility of various sulfur and copper dusts and sprays as possible substitutes for lime-sulfur for summer applications. This report considers only the effect of the different materials on the foliage and fruit of apples. All the spray and dust mixtures affected to some degree the surfaces of apple fruits. "Sun scald" or "spray burn" was the most conspicuous type of injury and was common in all of the plats receiving applications of sulfur either as lime-sulfur solution or flowers of sulfur, or sulfur flour applied as a dust. Russeting varied in intensity with the different treatments. Injuries to foliage were largely confined to plats sprayed with lime-sulfur solution. The addition of calcium caseinate, glue, and lime hydrate reduced to some extent injuries to both fruits and foliage, but they did not prevent important injury to foliage in some instances.

During recent years much interest has been aroused relative to the action of spray and dust mixtures on the quality of fruit as well as on the productive capacity of orchard trees, Advocates of dusting have pointed out that, generally speaking, dust preparations are more safe to foliage and fruit than certain common spray mixtures.

In spite of the fact that much can be said in favor of lime-sulfur for the treatment of both apples and pears for certain applications, it is generally recognized that this spray may injure foliage and, so far, there is very little definite information relative to the conditions that favor important damage, or regarding means of controlling its injurious properties and thus render it more safe.

Injuries by lime-sulfur vary greatly in kind as well as in degree. A very common form of injury is browning or "burning" of the tips and margins of the leaves. This may involve large areas of the leaves of a considerable proportion of the foliage and is frequently attended with premature defoliation of varying extent. In spraying trees for pear psylla this type of injury may be severe, and it is a question if in the long run applications do not cause more damage than the pest which prompted the treatment. Even tho the leaves may reveal no serious discoloration, apple trees sprayed repeatedly during the growing season may show very characteristic differences from unsprayed trees or trees

treated with wettable sulfur, bordeaux mixture or dust mixtures, as revealed by the number, contour and color of the leaves. Likewise, the fruits may be affected ,exhibiting russeted netting and blotches or dark, discolored, circular areas known as "sun scald," "spray burn," etc.

Bordeaux mixture also displays limitations since it may produce spotting of the leaves as well as marginal injuries, while the fruits may be russeted and distorted.

Growers, generally, are familiar with the effects of these two sprays and, pending the discovery of more desirable substitutes, seem willing to take chances of injury even tho in occasional years damage of an important extent may be sustained.

In the State of New York lime-sulfur is used extensively for the treatment of fruit trees, and for certain purposes there is no material which is quite its equal. From the standpoint of foliage treatment, however, there is need of a new spray equally effective as an insecticide and fungicide or some method should be developed of handling lime-sulfur which will render it more safe to foliage. For these reasons the Geneva Experiment Station has been testing for two seasons different formulas of "wettable sulfur" or "dry mix" sprays as possible substitutes for lime-sulfur, as well as hydrated lime, calcium caseinate and glue to determine their value in reducing the injurious properties of the lime-sulfur spray. It should also be noted that little or no consideration has been given to the problem of determining the accumulative effects of different systems of treatment, so provision was made to ascertain the effects of successive treatments of lime-sulfur and other materials on the productiveness of trees over a period of years.

In the experiments herein described, the spray materials were used at standard strengths, namely, lime-sulfur solution for foliage applications at the rate of 2.5 gal., to 100 gals., of water, and powdered lead arsenate 3 lbs., to 100 gals. Except as indicated, the formula for the "wettable sulfur" or "dry mix" spray was 4 lbs., lime hydrate, 8 lbs., sulfur, 1.5 lbs., powdered lead arsenate and 50 gals. water. Glue and calcium caseinate were used as spreaders at the rate of 4 ozs., glue or 1 lb., calcium caseinate to 100 gals. unless different amounts are indicated. The apple trees under treatment belonged to the variety Greening and were 25 years old. The spray mixtures were applied at the rate of 10 gals., per tree and 5 applications, which includes the delayed dormant treatment, were made during the season, as provided in the standard spraying schedule. The dust mixtures were used as stated in Table 1.

The more important data relative to injuries to fruit and foliage

TABLE 1. RELATION OF DUST AND SPRAY APPLICATIONS TO "SPRAY BURN" AND RUSSETING OF APPLES

Number of plat	Treatment	Number of trees examined	Average number of apples per tree	Av. no. of spray burn apples per tree	Percentage of spray burn apples	Condition of apples with respect to russeting
1	Spray (lime-sulfur with calcium caseinate)	9	1547	17.0	1.10	light *
2	Spray (lime-sulfur)	9	1724	21.0	1.23	moderate †
3	Spray (lime-sulfur with glue)	6	1217	8.0	0.68	moderate †
4	Spray (sublimed sulfur 8 lbs.)	10	1416	5.0	0.33	light *
5	Spray (sublimed sulfur 8 lbs. and lime hydrate 8 lbs.)	9	2265	0.5	0.01	light *
6	Spray (flour sulfur 16 lbs.)	9	2388	8.4	0.35	light *
7	Spray (flour sulfur 16 lbs., lime hydrate 8 lbs.)	10	1651	4.4	0.26	light *
8	Spray (flour sulfur 8 lbs.)	7	3486	6.6	0.18	light *
9	Spray (flour sulfur 8 lbs., lime hydrate 8 lbs.)	9	1895	2.2	0.11	light *
10	Dust (90–10 sulfur 5 lbs. per tree) regular schedule	9	1143	6.1	0.53	trace °
11	Dust (90–10 sulfur 2 lbs. per tree) weekly	10	1468	15.8	1.07	trace °
12	Dust (85–15 sulfur 5 lbs. per tree) regular schedule	8	1287	12.1	0.94	trace °
13	Dust (85–15 sulfur 2 lbs. per tree) weekly	7	1957	11.0	0.56	trace °
14	Dust (77–13–10 lime-copper, 4 lbs. per tree) regular schedule	10	1846	0.0	0.0	severe ‡
15	Dust (77–13–10 lime-copper, 4 lbs. per tree) weekly	6	1871	0.0	0.0	severe ‡
16	Dust (77–13–10 lime-copper, 2 lbs. per tree) regular schedule	7	1177	0.0	0.0	severe ‡
17	Dust (77–13–10 lime-copper, 2 lbs. per tree) weekly	9	1302	0.0	0.0	severe ‡
18	Dust (copper arsenite 4 lbs. per tree) regular schedule	10	1127	0.0	0.0	severe ‡
19	Check, no treatment	5	849	0.0	0.0	none
20	Dust (copper-arsenite-lime 2 lbs. per tree) regular schedule	8	1303	0.0	0.0	severe ‡
21	Dust (copper-arsenite-lime 2 lbs. per tree) weekly	7	1681	0.0	0.0	severe ‡
22	Dust (copper carbonate, 4 lbs. per tree) regular schedule	4	2225	0.0	0.0	severe ‡
23	Spray (copper carbonate, 4 lbs. per 100 gals.) reg. schedule	4	1289	0.0	0.0	severe ‡

°Trace. Barely discernible, not commercially important.
*Light. Noticeable, not commercially important.
†Moderate. Sufficiently important with a goodly percentage of the apples as to raise question of the proper grade of fruit.
‡Severe. Russeting so severe with varying percentages of the apples as to cause rejection from Grade A.

obtained in the experiments during 1923 are briefly summarized as follows:

Effect of Spray and Dust Mixtures on Fruits

All the spray and dust mixtures affected to some degree the surfaces of apple fruits. The most conspicuous type of injury was "sun scald" or "spray burn" characterized by the occurrence of somewhat circular brownish or brownish-black spots on the sides of the apples. These were most conspicuous on the south side of the tree where there was apparently the greatest exposure to sunshine, and were common in all of the plants receiving applications of sulfur either as lime-sulfur solution or flowers of sulfur or sulfur flour applied as a dust. (See Table 1). This type of injury was most abundant in the plats sprayed with lime-sulfur solution. In considering the number of apples affected with "spray burn" in relation to the total yield, it will be observed that the amount of injured fruit is not large, but, small as it is, it must be admitted that the size and color of the blemished areas are such as to produce in the mind of the one examining the trees that the damage is much greater than the actual counts indicate. Associated with "spray burn" there was russeting of the fruits, which was also noticeable in all the plats receiving applications of sulfur, both spray and dust. Judging from the number of apples affected and the effect of the discoloration on the general appearance of the yield, russeting was really more important than spray burn.

Russeting varied in intensity with the different treatments. In certain plats a small percentage of the apples were distinctly russeted so that the natural green color of the fruits over more or less extensive areas was largely or completely obscured. With the majority of the apples the discoloration appeared as streaks or netting in varying gradations. Even tho barely discernible, and therefore not conspicuous enough to be considered important, it is an interesting fact that a small amount of injury detracts from the appearance of the apples, as they lack to some extent the finish and luster of normal fruits.

In the plats sprayed with lime-sulfur russeting of apples was general, involving perhaps 80 or 90 percent of the fruits. It was especially noticeable about the calyx end, altho it was by no means confined to this region. The addition of calcium caseinate to lime-sulfur (1 lb. to 100 gals.), caused an appreciable reduction in the number of affected apples as well as in the severity of russeting, while 2 lbs., of the spreader to the

same volume of spray seemed to produce improved conditions in these respects. On the other hand, russeting was fully as conspicuous on the trees sprayed with lime-sulfur containing glue as those treated with lime-sulfur alone.

The "wettable sulfur" sprays produced a very noticeable amount of russeting, altho it was less than that caused by lime-sulfur. There was no apparent difference in the action of sublimed flowers of sulfur or flour sulfur, but russeting seemed to be somewhat more conspicuous whereever lime was used.

Sulfur applied as a dust caused some russeting that was unquestionably due to the treatment. This was very much less than that occurring in the lime-sulfur plats, and was even less conspicuous than that in the "wettable sulfur" plats. From the standpoint of the finish and luster of the fruits, the apples dusted with sulfur or sprayed with "wettable sulfur" were superior to those sprayed with lime-sulfur and were unexcelled by the product from any of the other treated plats.

The copper dusts used in all the treatments provided in the spray schedule, including the calyx application, caused more severe and more general russeting than any of the materials applied, occasional fruits being greatly distorted and revealing cracks which sometimes extended as far as the core. In general, the damage was more conspicuous in the plats which received a heavy dosage of 4 lbs., per tree, the copper arsenite dust being more injurious than the dehydrated copper dust. The so-called "spray scald" was entirely absent from the plats receiving applications of the copper mixtures.

Influence of Dust and Spray Mixtures on Foliage

The only plats treated with sulfur preparations that displayed injuries were those sprayed with lime-sulfur solution and these consisted largely of browning or burning of the tips and margins of the leaves. It was difficult to form any definite conclusions relative to the influence of either calcium caseinate or glue in reducing the damage. Lime hydrate was superior to either of these materials, and while its addition to lime-sulfur did apparently make this spray more safe, it by no means wholly prevented damage. The plats dusted with sulfur or sprayed with "wettable sulfur" showed no evidence of injury and during the entire season were readily distinguishable by the luster of the leaves from those sprayed with lime-sulfur. The foliage of the latter was dull colored.

Copper carbonate applied as a spray caused severe injuries, as indi-

cated by the development of brown spots in the leaves and browning of the margins. Subsequently a large proportion of the foliage dropped. The same material applied as a dust produced quite similar results, altho the injury was not so extensive.

Dehydrated copper sulfate and copper arsenite dusts exerted, on the whole, no injurious effects; at least not to any important degree, altho all the trees receiving heavy applications of copper dusts displayed characteristic brown spots which were diagnosed by various workers as frog eye (*Sphaeropsis malorum*). As these were observed only in the plats treated with the copper dusts, it is difficult to draw any other conclusion than that the spotting was primarily due to the treatment.

Conclusions

The standardization of apple grades and the growing discrimination against imperfect fruits in commercial packages have directed attention to the importance of spray injuries, revealing a need of safer spraying mixtures as well as improved methods of handling standard insecticides and fungicides to reduce danger of injury to fruit and foliage.

Of common spraying mixtures, none are quite as satisfactory as lime-sulfur for the treatment of apples. The chief defect of this spray is that it may cause burning of leaves as well as "spray burn" and russeting of the apples, injuries which vary in degree apparently with different sorts of apple and according to seasonal conditions. No methods have been devised by which these injuries may be entirely prevented or largely controlled. The addition of calcium caseinate caused an appreciable reduction in the amount of "spray burn" and russeting, but still both types of injury were conspicuous. Glue, apparently, was not as effective as calcium caseinate. Lime hydrate reduced burning of foliage to an appreciable extent, but did not prevent important damage in some instances. Since calcium caseinate as revealed by analyses[1] prevents any important reaction between lime-sulfur and lead arsenate and lime hydrate neutralizes the soluble arsenic developing from this combination, it would appear that sulfur is largely responsible for the damage to apple foliage and fruit and that sulfur contained in sulfides is more injurious than ground sulfur or sublimed flowers of sulfur applied as dusts or in suspensions.

Sulfur suspensions, known as "wettable sulfur" or "dry mix" sprays, were tested as possible substituted for lime-sulfur. They produced noticeable russeting as well as "spray burn" of apples, but the damage

[1]Unpublished analyses by Dr. R. W. Thatcher and L. R. Streeter.

was less than that of lime-sulfur. No difference was observed in the action of sublimed flowers of sulfur or flour sulfur. The addition of lime seemed to aggravate the injury. These sprays differed markedly from lime-sulfur in that they caused no injury to the foliage.

Sulfur applied as a dust produced both russeting and "spray burn" but both were very much less in evidence than in the plats sprayed with lime-sulfur. The general appearance of the fruit was superior to that treated with "wettable sulfur" or lime-sulfur.

The copper dusts caused no spray burn. Heavy applications produced severe russeting which was accompanied by cracking of the surfaces of the apples. The apples from trees receiving light dosages lacked the luster of fruits dusted with sulfur or sprayed with "wettable sulfur"

In the treatment of apples with dusts the danger of injury to fruit and foliage is not as great as with spraying mixtures. The undesirability of applying copper mixtures in the calyx application, which had long been recognized, seems to be corroborated by these tests. From the standpoint of pest control, as well as safety to plants, much is to be said in favor of frequent applications of light dosages of the different dusts as against heavy dosages at wider intervals.

The data from this series of experiments suggest no satisfactory spray as a substitute for lime-sulfur, altho the "wettable sulfur" mixtures should be given further trial. Likewise little light has been shed relative to methods of controlling injury by lime-sulfur. Under the circumstances all the grower can do is to follow the usual instructions such as, apply minimum amount of spray necessary to wet foliage; avoid coarse, drenching sprays; treat trees systematically according to schedule to combat both insects and diseases and thus prevent rupturing of foliage which facilitates spray injuries; add lead arsenate to lime-sulfur when ready to spray, and do not allow mixture to stand long before applying; employ calcium caseinate or lime hydrate to prevent or neutralize respectively, free arsenic formed by the reaction between lime-sulfur and lead arsenate; abstain from spraying during periods of high temperatures, etc.

Some varieties, such as Greenings, McIntosh and Ben Davis, have proved more susceptible to burning of foliage than other sorts; and Greening apples especially have generally been less free of spray scald and russeting than Rome apples, the injuries of different types varying considerably according to seasonal conditions and character of spraying

operations. With the former varieties it is sometimes a difficult problem, especially when scab is active, to spray the trees thoroly and not cause a certain amount of injury. However, more attention to such details on the part of the grower can hardly fail to be of considerable benefit.

The addition of calcium caseinate to lime-sulfur tended to more even distribution of the spray, and apparently reduced to some extent both "spray burns" and russeting. Its actual value for these purposes as well as its influence on the insecticidal efficiency of standard insecticides should receive further consideration.

MR. WILLIAM MOORE: I would like to ask what time of day the spraying was done.

MR. P. J. PARROTT: The dusting was all done in the morning.

MR. WILLIAM MOORE: You didn't notice any different burning from lime sulphur in the middle of the day?

MR. P. J. PARROTT: No.

VICE-PRESIDENT S. B. FRACKER: The next paper is by L. A. Stearns and W. S. Hough.

SPREADER TESTS ON APPLES AND PEACHES: A SECOND REPORT

By L. A. STEARNS and W. S. HOUGH, *Virginia State Crop Pest Commission*

ABSTRACT AND CONCLUSIONS

The efficacy of a casein spreader (Kayso) in the commonly recommended sprays for apple and peach has been studied for the second season. These sprays, with and without the spreader, were mixed by the writers and applied by the regular orchard force.

The second season's results parallel those of the first year's work. There is no indication that the incorporation of the spreader with the usual sprays influenced the protection of the fruit from insects and diseases. The conclusion is that the use of a casein spreader (Kayso) in the apple and peach sprays under orchard conditions in Virginia is not justified from the standpoints of effectiveness and economy.

In 1922, an investigation was commenced by the writers with the thought that since it had been shown under laboratory conditions that certain materials appear to influence the spreading and adherence of sprays it was equally desirable to demonstrate their effectiveness and economy in orchard practice. The spreader tests on apples and peaches discussed herein are a continuation of this study on which a preliminary

report has already been made[1]. This season, the tests were confined to casein (Kayso) with the object of determining its value as a spreader and adhesive not only in the summer sprays but in all applications of the scheduled programs for apple and peach.

Tests on Apples

Tests were conducted by the senior author in Mr. L. Clark Hoge's Ophir Orchard at Leesburg. The experimental section of this orchard was a 14-year old planting of the Grimes Golden, Gano and Rome Beauty varieties. At Winchester, tests were conducted by the junior author in the Stayman-Winesap orchard of the Shenandoah Vinegar Company. These trees, varying in age from 8 to 15 years, are subjected annually to a severe infestation of codling moth due to their proximity to large apple bins where cull apples are stored prior to being ground for cider.

The Virginia spray calendar for apples, in 1923, called for a delayed dormant spray of nicotine sulphate, 1–800, and winter strength lime-sulfur; sprays of powdered lead arsenate, 1 pound to 50 gallons, and summer strength lime-sulfur to be applied when the cluster buds are pink, when the petals are falling and two weeks after petal-fall; Bordeaux mixture, the 4–5–50 formula, and powdered lead arsenate, 1 pound to 50 gallons, to be applied four weeks and ten weeks after petal-fall.

At Leesburg, each variety received all applications as scheduled with and without the spreader, the spreader being used at the recommended rate of 1½ pounds to 200 gallons. At Winchester, on the other hand, Scalecide, 1–15, was substituted in the delayed dormant spray, and all other sprays were applied as scheduled with and without the spreader, the spreader being used at the increased rates of 2 and 3 pounds to 200 gallons.

In each orchard, the spray outfit was a 200 gallon Hardy. Both rods and guns were used, with a pressure varying from 225 to 300 pounds. One lead was operated from the tower and the other on the ground. The spray materials were mixed by the writers, and the applications made by the regular orchard force under their supervision.

At picking time, each variety was graded separately, and the results tabulated by plots. For convenience, the data for the three varieties at Leesburg are summarized in Table 1. The results at Winchester are given in Table 2.

[1]Jour. Econ. Entom., Vol. 16, No. 2, pages 198–201, April, 1923.

TABLE 1. RESULTS OF TESTS WITH CASEIN SPREADER ON APPLES, GRIMES GOLDEN, GANO AND ROME BEAUTY VARIETIES, LEESBURG, VIRGINIA, 1923

Type of Injury	Plot 1, 13,527 Apples Regular Treatment No Spreader		Plot 2, 15,601 Apples Regular Treatment With Casein Spreader 1–1½–200	
	No.	Percent	No.	Percent
Codling Moth.................				
Oriental Moth................	131	.97	163	1.04
Leaf Roller..................				
Bud Moth.....................	163	1.20	206	1.32
Curculio.....................	276	2.04	363	2.33
Aphis........................	354	2.62	827	5.30
[1]Warting Scars.............	1075	7.95	952	6.10
Scab.........................	689	5.09	583	3.74
Cedar Rust...................	75	.55	79	.51
Black Rot....................				
Bitter Rot...................	36	.27	38	.24
Spray Burn...................	528	3.90	612	3.92
Plot Averages................		2.73		2.72

TABLE 2. RESULTS OF TESTS WITH CASEIN SPREADER ON APPLES, STAYMAN-WINESAP VARIETY, WINCHESTER, VIRGINIA, 1923

Type of Injury	Plot 1 2,087 Apples Unsprayed		Plot 2 4,636 Apples Regular Treatment No Spreader		Plot 3 3,663 Apples Regular Treatment with Casein Spreader 2–200		Plot 4 3,570 Apples Regular Treatment With casein Spreader 3–200	
	No.	%	No.	%	No.	%	No.	%
Codling Moth....	1656	79.24	1235	26.64	888	24.24	1042	29.19
Leaf Roller......	18	.86	13	.28	7	.19	27	.75
Curculio.........	15	.71	34	.73	28	.76	18	.50
Sooty Blotch.....	495	23.23	102	2.20	176	4.80	44	1.23
Plot Averages....		26.04		7.46		7.50		7.97

From the results in Tables 1 and 2, it is evident that the sprays without the spreader gave equally as efficient protection to the fruit as the sprays with the spreader added. In no case does the difference in the average amount of injury in the several plots exceed one percent.

It was concluded from the previous season's work that Nicotine Sulphate 40% (Black Leaf 40) and casein (Kayso), as used were uncongenial. In this connection, attention is called especially to the

[1]Miscellaneous insect injuries of a character which made immediate determinations at the time of grading doubtful were for convenience grouped under the heading, "warting scars."

relative percentages of aphis injury on the "no spreader" and "spreader" plots, as given in Table 1. It should be added, here, that this injury was consistently more severe on the "spreader" plots; doubled in the case of Grimes Golden and Gano varieties and trebled in the case of Rome Beauty variety. Apparently, casein (Kayso), when used at the recommended rate, and nicotine sulphate 40% (Black Leaf 40), when used at the usual dilution, do not occur in the spray solution in the correct proportions to react properly. It has been brought to the writers' attention that to prepare nicotine-caseinate the reaction seems to require 1 gm. of casein to 1 cc. of nicotine. Casein and nicotine sulphate, as used in the previous work and here as well, are present in the spray solution in the approximate proportions of 2 gms. of casein to 3 cc. of nicotine. It is suggested that herein may be found an explanation of the uncongeniality noted.

Tests on Peaches

The information in this particular, as in the preliminary report, is incident to the Oriental Fruit Moth project of the Crop Pest Commission. Spraying operations in the experimental control of this insect in 1923 were conducted in the American Fruit Growers Inc. Loudoun Orchard at Leesburg. This is a young Delicious apple orchard interplanted with peaches of the Carman and Belle varieties. It was in its fourth year and bearing its first crop.

The schedule of treatments in this orchard was that commonly recommended for peaches. The usual dormant application of winter strength lime-sulfur was followed by a "shucks-off" spray of powdered lead arsenate, 1 pound, and hydrated lime, 4 pounds, to 50 gallons, the same, with 8 pounds of sulfur added, being repeated three weeks later. One month before the fruit ripened, an 8–4–50 sulfur-hydrated lime spray was applied.

In this experiment, four of the test plots in which both varieties were represented gave results pertinent to the effectiveness of casein. Test or plot 1 received the regular treatment without the spreader; plot 2, the casein spreader in all applications; plot 3, nicotine sulphate 40% in the summer applications; plot 4, nicotine sulphate 40% in the summer applications and casein in all applications. Nicotine sulphate 40% (Black Leaf 40) was used at the 1–800 dilution and casein (Kayso) at the recommended rate of 1½ pounds to 200 gallons of the spray solution.

The spray outfit used was a 200 gallon Bean equipped with two two-nozzle rods. It was operated at a pressure varying from 250 to 275

pounds. Both leads were handled from the ground. The spraying was done from only one side of the row, each operator encircling the trees in his row as the outfit moved across the orchard. The spray materials were mixed by the senior author and the applications made by the regular orchard force under his supervision.

When the peaches were picked, they were graded and the results tabulated by varieties. As in the case of apples, the variety variations were so slight that the results have been combined in Table 3.

It will be noted by reference to Table 3 that the results are in complete accord with those secured in the tests on apples. Again, in no case does the difference in the average amount of injury in the several plots which received or failed to receive the spreader, exceed one percent. Furthermore, these results parallel exactly those reported for peaches in 1922.

TABLE 3. RESULTS OF TESTS WITH CASEIN SPREADER ON PEACHES, CARMAN AND BELLE VARIETIES, LEESBURG, VIRGINIA, 1923

Type of Injury	Plot 1 41,079 Peaches Regular Treatment No Spreader		Plot 2 66,938 Peaches Regular Treatment with Casein Spreader		Plot 3 89,460 Peaches Regular Treatment with Nicotine Sulphate 40%		Plot 4 52,285 Peaches Regular Treatment With Nicotine Sulphate 40% and Casein Spreader	
	No.	%	No.	%	No.	%	No.	%
Curculio........	3974	9.674	6347	9.481	9432	10.543	4683	8.956
Brown Rot......	29	.070	37	.055	75	.083	36	.068
Scab...........	143	.348	159	.237	380	.424	216	.413
Spray Burn.....	2024	4.927	1221	1.824	1444	1.614	934	1.786
Plot Averages...		3.755		2.899		3.166		2.806

MR. F. A. FENTON: I would like to ask if chemical tests were made of the leaves sprayed with casein to determine the amount of arsenic or lead oxide present.

MR. L. A. STEARNS: No such tests were made.

MR. F. A. FENTON: This year in Iowa we have been conducting some experiments for controlling the apple maggot. One hundred leaves were picked from one hundred different trees that had been treated with casein and we found twice as much lead oxide after a period of 18 days on fruit that had been sprayed with casein than on fruit where casein had not been used.

MR. WILLIAM MOORE: Did I understand that you sprayed with nicotine sulphate and casein?

MR. L. A. STEARNS: No.

MR. H. A. GOSSARD: We have noted in Ohio at least 2 or 3 cases in which casein was used with the spray and more burning resulted than where it was omitted.

MR. LAWSON CAESAR: I have seen serious burning from using casein with lime sulfur and arsenate of lead. In some cases the burning was so severe at the end of the spraying season that I would not care to use casein again because of this injury.

VICE-PRESIDENT S. B. FRACKER: The next paper is by Mr. F. Z. Hartzell.

THE ESTIMATION OF DOSAGE FOR VOLATILE DUSTS: AN ILLUSTRATION OF THE VALUE OF CORRELATION MATHEMATICS TO ENTOMOLOGY

By F. Z. HARTZELL, *Vineyard Laboratory, Fredonia, N. Y.*

ABSTRACT

The term volatile dust is proposed for materials which kill insects by the evolution of toxic gases. It is suggested that dosage with such preparations be defined as the number of cubic feet of *tree volume* and *tree space* occupied by one pound of dust. Experiments with volatile dusts for the control of pear psylla, in western New York, have indicated that, for this insect, on the basis of tree volume, one pound of dust should not occupy a space of more than 1500 cubic feet, and, on the basis of tree space, the maximum volume should be 1900 cubic feet. Correlation and partial correlation calculations were used to study the relation of efficiency to dosage, temperature, and percentage of *open space*. Dosage was found to exert the greatest influence. The effect of temperature was not as marked as laboratory studies indicate and this was, doubtless, due to the increased convection currents and decreased humidity that usually accompany rise in temperature under field conditions.

The expression "contact dust" is ambiguous because it includes substances which kill, more or less, by direct contact and those that destroy insect life by evolving toxic gases. The term "volatile dust" is proposed for the latter class.

The advent of volatile dusts has introduced problems that do not arise in the use of ordinary contact or arsenical dusts, chief of which is the envelopment of the plant with a dose of gas lethal to the pest. They are problems of open air fumigation. Successful fumigation depends upon the density of the gas and the time during which it is allowed to act, the former being based upon the amount of materials used per

cubic foot. The writer proposes to place the dosage of volatile dusts upon the same basis. Briefly, dosage is the number of cubic feet of *tree volume* or *tree space* occupied by one pound of dust.

Definitions

By *tree volume* (T_v) is meant the cubic contents of an imaginary right cylinder having a diameter (D), which is the mean diameter, and a height (H) the same as that of the tree under investigation, all measurements being in feet and tenths. Mean diameter is the average of two diameters of the tree taken at right angles to each other. In mathematical symbols, $T_v = 0.785\ D^2H$. Dividing this product by the number of pounds of dust used on the same tree $\left(\frac{T_v}{P}\right)$ gives the number of cubic feet occupied by one pound of dust on the basis of tree volume. Since pear trees vary in shape and habit and because, when enveloped, the cloud does not conform closely to the contour of the tree, a cylinder represents the space as well as a more complicated solid and, in addition, the volume is easily computed.

Tree Space (T_s) is the product of the planting distances and the height; for example, a tree 16 feet high, planted 20 x 18 feet would have a tree space of 5,760 cubic feet. This result divided by the amount of dust used on the tree $\left(\frac{T_s}{P}\right)$ gives the number of cubic feet occupied by one pound of dust, on the basis of tree space. The difference between tree space and tree volume is designated *open space* (S_o).

Percentage of open space $= 100\frac{S_o}{T_s}$.

Nature of Experiments and Data

During pear psylla experiments in western New York, 1921–23 inclusive, a total of 15, 802 trees (86 acres) were dusted in cooperative field trials. These tests included dusts of varying nicotine content but the majority were 2 per cent lime-nicotine mixtures. Owing to cost, a number of growers used less material per tree than recommended, with the result that scme failures occurred but it gave an excellent opportunity to determine the effect of dosage.

The greatest difficulty, from a biometrical point of view, was the limited number of trees upon which data could be secured, owing to

the amount of time required for counting the thousands of dead psylla and for re-dusting the "count" trees to determine the survivors of the original application. This gave the data from which to calculate the percentage efficiency of the operation. In addition, generally, the following data were secured on each count tree: size and shape (the latter by means of photographs), planting distances, amount of dust applied, and temperature. A total of 46 trees, treated with 2 per cent lime-nicotine dust of practically the same toxicity, had simultaneous measurements of the following variables: (1) Per cent efficiency of the operation; (2) dosage, (3) temperature, and (4) percentage of open space. Some of the statistical constants, calculated from the data, are given in Table 1.

TABLE 1. MEANS, STANDARD DEVIATIONS, COEFFICIENTS OF VARIABILITY, AND RANGE OF VARIABLES IN PEAR PSYLLA EXPERIMENTS

Variable	Mean	Standard Deviation	Coefficient of variability	Range
Percentage of efficiency of operation...........	72.78 ± 1.69	17.03 ± 1.20	23.40 ± 2.45	32.8—99.0
Dosage on basis of tree volume (cu. ft.)...........	2931.22 ± 122.67	1233.46 ± 86.74	42.08 ± 4.87	1218—5359
Dosage on basis of tree space (cu. ft.)...........	4529.78 ± 266.78	2682.51 ± 188.63	59.22 ± 5.91	1688—11000
Temperature Fahr.	71.44 ± 0.69	6.93 ± 0.49	9.70 ± 0.97	61—84
Percentage of open space.........	28.59 ± 1.70	17.07 ± 1.20	59.71 ± 5.96	0—60.4

CORRELATION

The first three problems presented are the following: (1) effect of dosage on efficiency, (2) the influence of temperature on efficiency, (3) the relation of open space to control. The simplest method of measuring the effect of one variable upon another is to determine the correlation coefficient (r), the variables involved being indicated by subscripts. These are known as zero order coefficients and mean that the relation between two variables has been measured without regarding the influence of other variables. The mathematics of correlation will not be presented because they are explained in detail in a number of elementary texts on statistics. The subscripts denoting the several variables in the investigation are as follows:

subscript 1 indicates the percentage efficiency of the operation,

subscript 2, the dosage on the basis of tree volume $\left(\frac{T_v}{P}\right)$

subscript 3, the temperature.

subscript 4, the percentage of open space $\left(100\ \frac{S_o}{T_s}\right)$,

subscript 5, the dosage on the basis of tree space $\left(\frac{T_s}{P}\right)$.

For example, r_{12} is the correlation coefficient between percentage of efficiency and dosage $\left(\frac{T_v}{P}\right)$, when the temperatrue and open space is allowed to vary. The value of these zero order coefficients are given in Table 2.

TABLE 2. CORRELATION COEFFICIENTS OF VARIABLES INVOLVED IN PEAR PSYLLA EXPERIMENTS

Zero Order Coefficients	First Order Coefficients	Second Order Coefficients
r_{12} $-.502 \pm .074$	$r_{12\cdot3}$ $-.467 \pm .078$	$r_{12\cdot34}$ $-.464 \pm .078$
r_{13} $-.246 \pm .093$	$r_{12\cdot4}$ $-.486 \pm .076$	$r_{13\cdot24}$ $+.150 \pm .097$
r_{14} $-.188 \pm .096$	$r_{13\cdot2}$ $+.137 \pm .098$	$r_{14\cdot23}$ $-.138 \pm .091$
r_{15} $-.411 \pm .083$	$r_{13\cdot4}$ $-.220 \pm .095$	
r_{23} $+.667 \pm .055$	$r_{14\cdot2}$ $-.124 \pm .098$	
r_{24} $+.164 \pm .097$	$r_{14\cdot3}$ $-.152 \pm .097$	
r_{34} $+.175 \pm .096$	$r_{23\cdot4}$ $+.657 \pm .057$	
	$r_{24\cdot3}$ $+.065 \pm .099$	
	$r_{34\cdot2}$ $+.089 \pm .099$	

It will be noted that these values seem to indicate that the most important factor involved in the successful application of volatile dust is the dosage (r_{12} and r_{15}). Another important result should also be noted: viz, a negative correlation between efficiency and temperature (r_{13}) which would mean that, within the range of temperature involved in the experiments—61 to 84 degrees, Fahr.—increase in temperature decreased the control. This is contrary to the results of laboratory experiments by other workers who claim that the correlation is positive. The examination of the data (omitted because of lack of time) reveals the fact that, in most instances the heavier dosages were applied when the temperature was low and the correlation coefficient r_{23} confirms this, indicating that the effect of temperature is masked by the influence of dosage. This point will be discussed subsequently under partial corre-

lation. The relation between efficiency and open space seems also to be slight.

Partial or Net Correlation

In an ideal experiment, two factors are allowed to vary while all other influences are held as nearly constant as possible. Such investigations are practically impossible in the field. What is needed is a measure of the relationship between two variables when the other variables are held constant. This measure is provided by partial or net correlation coefficients. The notation needs explaining. Partial correlation coefficient subscripts have a decimal form. The two subscripts to the left of the period are known as primary subscripts and indicate the variables measured, while the subscripts to the right of the point are designated secondary subscripts and show what factors are held constant. For example, $r_{14.23}$ shows that the correlation is measured between efficiency and percentage of open space, when the dosage and temperature are held constant.

The chief problem to be solved is this: what is the net correlation between the percentage of efficiency and the dosage when all the trees are considered constant as regards temperature and percentage of open space? Stated otherwise, is the difference between r_{12} and $r_{12.34}$ significant? Another question which demands an answer is; what is the effect of temperature on efficiency when dosage and open space is kept constant? The values of the first and second order coefficients are set forth in Table 2.

It will be noted that the difference between r_{12} and $r_{12.34}$ is $.038 \pm .108$, which is not significant since the probable error is greater than the difference between the two coefficients. The objection may be raised that the number of observations is small (46). Suppose that there were 414 observations and assume that the coefficients remain the same, all the probable errors would be only one-third those shown in Table 2. The difference between r_{12} and $r_{12.34}$ would then be $.038 \pm .036$ and would still lack significance. In other words, the variation due to temperature and open space have not, apparently, affected the relation between efficiency and dosage. The same might be said of the relation between efficiency and open space ($r_{14.23}$). It is vastly different as regards the effect of temperature on efficiency when dosage and open space is held constant. for $r_{13.24}$ is positive. The difference between r_{13} and $r_{13.24}$ is $.396 \pm .134$, which is almost significant notwithstanding the paucity

of numbers. This substantiates the work of Rudolf[1]. The reason the coefficient ($r_{13 \cdot 24}$) is not larger is, perhaps, due to the fact that convection currents are greater and humidity less with rise in temperature, the former making envelopment of the tree more difficult.

This study illustrates the danger of using zero order coefficients alone in drawing conclusions and shows the necessity of measuring as many simultaneous variables as possible and investigating by means of partial correlation before drawing conclusions. In the experiments discussed, it must be concluded that the results are indicative but do not have as great an element of certainty as would have been possible with a larger number of observations. However, the method of analyzing the data rests upon a substantial foundation and one purpose of the paper is to show this need. To use partial correlation, two conditions are necessary; (1) all zero order correlation must have linear regressions, and (2) the number of observations must be large.

Determination of Dosage

The determination of dosage is now a simple matter since it has been shown that, to a certain extent at least, the influence of temperature, when above 60° Fahr., can be safely ignored in calculating dosage. In making recommendation, on the other hand, 65 degrees Fahr., should be set as a minimum for orchard operation. However, because the number of observations is rather limited, and since dosage plays so important a part in success, it is suggested that growers take account of the amount of open space, at least, until further investigation has definately proven that this is not a factor. If all the trees where the efficiency is 80 per cent or more be assumed as successes, it will be noted that there were no failures when the number of cubic feet of tree volume was 1,500 or less, and, on the basis of tree space, 1,900 cubic feet or less.

In order that a grower may determine the amount of dust to use, several average sized trees should be measured and the amount of material for each calculated on the basis of tree volume and then on the basis of tree space. The larger amount is the correct dosage for each tree. Add these together and take the average, multiplying by the number of trees in the orchard will give the amount of dust for one application. It may be of interest to note that on the basis of these studies, the requirements for 72 trees, which were the average in a number of orchards, varied from 0.86 lb., to 4.09 lbs., with a mean of 2.53 pounds per tree.

[1]Rudolfs, Willem. Nicotine Delivery from Dust Carriers. Jour. Econ. Ent., 15:421–424, 1922.

The results presented in this paper are based upon experiments for the control of pear psylla in commercial orchards in western New York and the particular dosages apply strictly to 2 per cent lime-nicotine dust for the control of the same insect in this region. How general they will hold for psylla in other regions or for other pests can be determined only by experiments. However, the methods of determining dosage are believed to be of general application for volatile dusts on different trees and for various insects.

VICE-PRESIDENT S. B. FRACKER: The next paper is by J. J. Davis.

COMPARATIVE TESTS WITH DORMANT SPRAYS FOR SAN JOSE SCALE CONTROL

By J. J. DAVIS, *Purdue University, Lafayette, Indiana*

ABSTRACT

A record of outstanding results obtained for three years (1921–1923) with lime-sulphur and oils as dormant sprays for the control of the San Jose scale, *Aspidiotus perniciosus* Comst., Lime-sulphur did not give a sufficient kill to check the scale, which corroborated the results obtained by commercial orchardists in southern Indiana. Lime-sulphur is still an effective scale control in most sections of northern Indiana. Dry lime-uslphur was about as effective as the liquid concentrated provided it was used at one and one-half to two times the strength recommended by the manufacturers. Under conditions existing the past few years in most of southern Indiana, the oil sprays are the only ones which have given satisfactory control. These include the miscible oils, "petroleum soaps," and oil emulsions. The summer use of oil emulsion cannot be recommended to take the place of a dormant spray although under certain conditions a summer application materially assists in checking scale.[1]

The seeming increasing importance of the San Jose scale, *Aspidiotus perniciosus* Comst., and its possible seriousness a few years hence was recognized in making our first survey of the important orchard pests of Indiana in the winter of 1920–21. These conditions prompted us to begin a series of experiments in the spring of 1921 on the comparative value of the sulphur and oil sprays. The lubricating oil emulsion was included in the tests during the summer of 1922, following the apparently phenomenal results secured by Ackerman in Arkansas in the spring of that year.

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[1]In a badly infested orchard at Washington, Indiana, sprayed in August 1923 with a two per cent oil emulsion, the scale was sufficiently checked to avoid much of the fruit spotting which would otherwise have resulted. A count in this orchard made February 1924 revealed 91 per cent dead scale. In part of this orchard an additional dormant application of a two per cent emulsion was made in December, 1923 and here 100 per cent of the scale were dead so far as our extensive counts revealed.

The object of the present paper is to briefly record some of the outstanding results of the tests referred to above. As our earlier observations indicated, the San Jose scale situation became acute in Indiana more than a year ago. The majority of apple orchards, at least in the southern half of the state, are infested. Many trees have been seriously injured and even entire orchards have been wiped out. Even the peach, which has heretofore been little troubled with the scale, has become badly infested in some instances. The work in Indiana was taken over by B. A. Porter, when he came to Indiana, in the spring of 1923, and he has had the opportunity to carry on extensive tests of fundamental importance. None of Porter's results are here recorded.

The three years of tests are summarized in Table 1. An explanation of points which could not be included in the tables follows:

All localities where tests were made are in the southern half of Indiana, most of them in the southwestern part of the state. All tests were on apple.

The applications in the spring of 1921 were made March 22 and 23 at Washington and March 24 and 25 at Staunton. At that time the leaf buds were opening and the leaves partly unfolded. As might be expected from applications at this late date, the miscible oil slightly injured foliage, but no permanent injury resulted. Counts of dead and live scale were made April 23–24, not less than 250 scales from representative twigs being counted in each case. The twig counts and leaf infestation made in June and September respectively gave results comparable with the counts of dead and live scale. This was true of the later experiments and no further reference is made of the twig and leaf counts in the tables. Counts of live and dead scale were made from the Staunton plots April 26. Methods used are given in more detail in our paper on "Estimating the Abundance and Damage by the San Jose Scale," to be published in the JOURNAL OF ECONOMIC ENTOMOLOGY.

In the 1921–22 experiments conducted at Bicknell and Washington, tests comparing the different types of dormant sprays were continued and were extended to include comparisons with fall and spring applications. The tests were made on heavily infested trees. At Bicknell, the fall applications were made Dec. 8, 1921, and the spring treatments March 16, 1922, while at Washington the fall tests were made Dec. 10–15, and the spring ones March 13–15. Counts of 500 scales were made the last of April. An additional 500 were counted in the Washington tests May 27–28 and the reults were practically the same as

TABLE I. SUMMARY OF RESULTS IN SAN JOSE SCALE DORMANT SPRAY EXPERIMENTS, INDIANA, 1921–23

Treatment	Time of application	Percent dead	Control
Washington, Indiana, 1921			
Miscible oil (Scalecide) 1 to 15. . ., ...	Spring	94.2	80
Liquid lime- sulphur (several brands) 1 to 7½	"	88.4	60
" " " " " 1 to 16 2/3.	"	66.4	-0
Dry " " 12½ lbs. to 50 gals. (label strength)	"	79.1	28
" " " 18¾ " " " " 1½ x " ")	"	83.8	44
" " " 25 " " " " (2 x " ")	"	84.4	46
B. T. S. 13 " " " " (label strength)	"	75.2	14.4
" 19½ " " " " (1½ x " ")	"	80.0	31
" 26 " " " " (2 x " ")	"	91.6	71
Check—no treatment		71.0	0
Staunton, Indiana, 1921			
Miscible oil (Scalecide) 1 to 15.	Spring	97.2	
Liquid lime-sulphur (several brands) 1 to 7½	"	89.2	93
Dry lime- sulphur (several brands) 12½ lbs. to 50 gals.	"	77.2	72
(label strength)			42
" " " " " 18¾ lbs. to 50 gals.	"	88.8	
(1½ x label strength)	"		71
B. T. S. 13 lbs. to 50 gals. (label strength).	"	79.2	
" 19½ lbs. to 50 gals. (1½ x label strength).	"	89.6	46.6
Check—no treatment.	"	60.8	73.4
Washington, Indiana, 1921-22			
Miscible oil (Scalecide) 1 to 15.	Fall	100	100
" " " 1 to 15.	Spring	100	100
Liquid lime- sulphur (several brands) 1 to 8.	Fall	85.8	53
" " " " " 1 to 8.	Fall & Spring	97.6	92
" " " " " 1 to 8.	Spring	94.4	81
Dry " " " " 1½ x label strength	Fall	93.4	78
" " " " " 1½ x label strength	Spring	87.9	59.6
Check—no treatment.		70.0	0
Bicknell, Indiana, 1921–22			
Miscible oil (Scalecide) 1 to 15.	Fall	98.4	96
" " " 1 to 15.	Spring	97.6	94
Liquid lime-sulphur (several brands) 1 to 7½	Fall	78.4	44
" " " " " 1 to 7½	Fall & Sp.	90.0	74
" " " " " 1 to 7½	Spring	91.2	77
Dry " " " " 13½ lbs. to 50 gals. (label strength)	Fall	71.2	25
" " " " " 13½ lbs. to 50 gals. (Label strength)	Spring	85.0	61
" " " " " 27 lbs. to 50 gals. (2 x label strength)	Spring	92.8	81

Check—no treatment		61.6	0
Washington, Indiana, 1922–23			
Miscible oil (Scalecide) 1 to 15	Fall	100	100
Lubricating oil emulsion 2 per cent	"	98.2	97.5
Liquid lime-sulphur 1 to 7½	"	82.4	75.8
Check—no treatment		27.2	0
Bicknell, Indiana, 1922–23			
Miscible oil (Scalecide) 1 to 15	Fall	99	96.6
Miscible oil (Scalex) 1 to 15	"	100	100
Petroleum soap (Sunoco) 1 to 15	"	100	100
Lubricating oil emulsion 2 per cent	"	97.8	93.8
Liquid lime-sulphur 1 to 6	"	80	44.4
Check—no treatment		64	0
Paoli, Indiana, 1922–23			
Miscible oil (Scalecide) 1 to 15	Fall	99.3	98.8
Petroleum soap (Sunoco) 1 to 15	"	99.1	98.5
Lubricating oil emulsion 2 per cent	"	96.4	93.7
Check—no treatment		41.2	0

[1]Percentage of scale actually killed by spray, figured after the per cent dead in check had been eliminated.

[2]The results recorded here are from the best of the several dry limesulphurs tested.

earlier counts except in the case of the lime-sulphur tests which ran rather uniformly slightly higher by one to two per cent.

The 1922–23 tests were made in three localities, those at Bicknell being made Nov. 21, 1922; at Washington, Nov. 23; and at Paoli, Nov. 24. Counts were made Feb. 26, Feb. 25, and Feb. 27, respectively. From 500 to 1,000 scales were counted in each test.

The spray rod with angle disk nozzles were used where they were available and where the guns was used, special care was exercised in securing thorough applications. The 1921 applications were made by the writer; those in 1921–22 by C. R. Cleveland, J. J. Culver and the writer; those in 1922–23 by C. R. Cleveland and the writer. Most of the counts were made by C. R. Cleveland and the writer, but material assistance was secured from J. J. Culver, W. P. Flint, and B. A. Porter in making supplementary counts as a check.

Results: We have concluded from these tests and many scattered observations, that the dry lime-sulphur is inefficient against the San Jose scale as it occurs at the present time in Southern Indiana when used at label strength. The liquid concentrate proved ineffective under the conditions which have prevailed in Southern Indiana the past few years. These results are corroborated by results secured where the scale could not be checked even when 1–6 strengths were used thoroughly. Even with a 90 per cent kill, the 10 per cent live scales on moder-

ately or heavily infested trees are able to increase and encrust a vigorous tree by fall. The dry lime-sulphur when used at twice label strength was about equal in effectiveness to the liquid concentrate.

The oil sprays were uniformly effective. From our tests reported above, general observations, and further tests by Porter, we would recommend a three per cent strength of the new lubricating oil emulsion where the trees are incrusted or where the scale seems to be increasing.

It might be noted in addition that rather uniformly better results were obtained by spring than by fall applications, in the case of lime-sulphur but in the case of the oil sprays, the time of application seemed to make no difference in the effectiveness of the material.

No recommendations are being made at the present time relative to the use of the new lubricating oil emulsion as a summer application. Peaches are likely to be injured. Under ordinary conditions apples in foliage are not injured and although some growers have been able to prevent scale spotting to a large extent by spraying in the summer with a two per cent emulsion, our results will not permit us to recommend the summer use of the emulsion or any other spray for the control of the San Jose scale. Because of variable results obtained by growers under conditions known to us, the emulsion cannot yet be recommended as an aphis control. Furthermore, only the *boiled* emulsion is at present recommended for scale control in Indiana.

MR. F. A. FENTON: I would like to ask Mr. Davis in what amounts the spray should be applied on apple?

MR. J. J. DAVIS: Our experience was only with the Oyster Shell Scale on lilac and similar shrubs. We have had no trouble with the Oyster Shell Scale in apple orchards which is a different form from the common one on apple, but doubtless controlled by the same measures.

MR. O. I. SNAPP: I would like to ask Mr. Davis what has been his experience, and what results he obtained from the use of the cold-stirred mixture.

MR. J. J. DAVIS: Our experience with cold-stirred mixture was not sufficient to warrant making any further statement. We have not been able to make uniform preparations in all cases with cold-stirred methods, and our results in experimental work are not sufficient to make any definite statements, except that we are not ready to recommend it.

MR. LEONARD HASEMAN: We used the cold-stirred oil emulsion in Missouri and in our experimental tests we got practically the same

results with the boiled emulsion. It is oil apparently that does the killing.

VICE-PRESIDENT S. B. FRACKER: The next paper will be by F. H. Larop and V. M. Trask.

FURTHER STUDIES OF PRUNE ROOT BORER CONTROL IN OREGON

By FRANK H. LATHROP AND VICTOR TRASK, *formerly of the Oregon Agricultural Experiment Station*

ABSTRACT

This paper is a report upon experiments conducted in Oregon during the season of 1922 in the control of the Prune Root Borer, *Sanninoidea opalescens* Edw. The treatments tested include Naphthalene Whitewash and the application of Paradichlorobenzene.

The Naphthalene Whitewash consisted of a basic formula composed of quicklime, copper sulfate, glue, and ground wood pulp, with sufficient water to form a thick paint. To this were added mixtures of naphthalene and paraffine in solid solution or naphthalene alone. The wash was applied to the tree trunks to a height of 14 to 16 inches after the soil had first been removed and the bases of the trees protected from the naphthalene fumes by means of paper collars or by a preliminary "protective" wash. In general, the treated plots showed a reduction in infestation. Best results were secured by the use of naphthalene-paraffine mixtures applied in connection with a preliminary protective wash.

Applications of one ounce of Paradichlorobenzene about the bases of the trees during the first week of September, gave excellent results when left undisturbed until the following spring. Larvae situated some distance above the soil level were not affected by the treatment. In heavy soils the action of the material was slower than in lighter soils. When this material was improperly applied or very young trees treated, severe injury resulted to prune trees.

The present paper is a report of results of applications made for the control of the prune root borer (*S. opalescens* Edw.) in the orchards of western Oregon during the summer and fall of 1922. The treatments applied include naphthalene whitewashes,[1] and paradichlorobenzene.

NAPHTHALENE WHITEWASH TREATMENTS

BASIC FORMULA. In each plot the basis of the wash was the same, but the nature and amount of the active material was varied. The basic wash was made up according to the following formula:

Quicklime	8 pounds
Copper sulfate	¼ pound
Glue	½ pound
Ground wood pulp	½ pound
Water to make a thick paint	

[1]Lathrop, F. H., and Black, A. B.: Jour. Econ. Ent., v. XIV, pp. 328–336, 1921.

The quicklime forms the body of the wash; the copper sulfate was added because of its fungicidal nature; while the glue, of course, serves as a sticker. The ground wood pulp was obtained from a paper mill, and was added to give increased body to the wash and to prevent cracking of the wash upon drying. For these purposes, the pulp served very well, but we do not regard its addition as highly important.

ACTIVE INGREDIENTS. In all of the washes applied, the active material was either naphthalene or mixtures of naphthalene and paraffine in various proportions. In making preparations of naphthalene and parraffine, the two materials were melted together over a gas flame. The naphthalene was readily soluble in the paraffine in the liquid state, and by rapidly cooling the melted material in thin layers on a glass plate, a solid solution of naphthalene and paraffine resulted. This material was ground in an ordinary food chopper to reduce it to a coarse granular form which was readily incorporated in the whitewash mixture.

The following are the combinations which were added to the basic formula:

Formula No. 1–22	Naphthalene:			1 lb.
2–22	Naphthalene:	paraffine[2]	1:1	1 lb.
3–22	Naphthalene:	paraffine	2:1	1½ lbs.
4–22	Naphthalene:	paraffine	3:1	21 oz.
5–22	Naphthalene:	paraffine	2:1	1 lb.
6–22	Naphthalene:	paraffine	3:1	1 lb.
7–22	Naphthalene:	"Parowax"[3]	3:1	1 lb.

METHODS OF APPLICATION OF NAPHTHALENE WHITEWASH. In nearly all cases the soil was removed from the bases of the trees to the depth of four to six inches before the wash was applied. The base of the trunk was then fitted with a paper collar or painted with a protective wash[4] to eliminate the injurious effects of the naphthalene fumes below the soil level.

After the paper collar was in place or the "protective wash" had dried the naphthalene wash was applied to the crown and trunk of the tree to a height of 14 to 16 inches. The soil was replaced about the base of the tree.

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[2]Paraffine used was a commercial grade obtained from the Standard Oil Company. Melting point about 48° C.

[3]Trade name for a refined grade of paraffine prepared and sold by the Standard Oil Company.

[4]The "protective wash" consisted of the following ingredients:

Quicklime	4 lbs.
Copper sulfate	2 oz.
Glue	4 oz.
Powdered charcoal	1 lb.
Water to form a thick paint	

TABLE I. RESULTS OF THE NAPHTHALENE WHITEWASH TREATMENTS, COTTAGE FARM, SALEM, OREGON, 1922

Applications made June 21. Results noted December 1.

Treatments		Results					
Formula	Method of Application	Number of trees treated	Number of trees wormed	Trees Infested Number	Trees Infested Per cent.	Number of Worms Total	Number of Worms Per tree
1.22 Naphthalene	Paper collar	14	8	3	37	4	.50
1.2 '	Protective wash	14	8	2	25	4	.50
1.22	Soil not removed.						
	Cotton band at base	14	8	3	37	12	1.50
2.22 Naphthalene:							
Paraffine 1:1 2 lbs.	Paper collar	14	8	2	25	3	.37
2.22	Protective wash	15	8	0	0	0	0
3.22 Naphthalene							
Paraffine 2:1 1½ lbs.	Paper collar	14	7	2	28	4	.57
4.22 Naphthalene:							
Paraffine 3:1 21 oz.	do	14	7	2	28	3	.43
4.22	Pro ectiv.: was'h	15	8	2	25	2	.25
4.22	So'l not removed						
	Cotton band	15	8	5	62	10	1.25
5.22 Naphthalene:							
Paraffine 2:1 1 lb.	Protect:v was	15	8	2	25	2	.25
6.22 Naphthalene:							
Paraffine 3:1 1 lb.	do	14		2	2 :	2	25
7.2 ? Naphthal ne:							
Parowax 3:1 1 lb.	Paper collar	15	8		37	4	50
Checks —no treatment			34	2	4		.00

Results as shown in table 1 indicate a general reduction of infestation in the treated plots as compared with the checks. The best results were obtained with formula 2–22 used in connection with a protective wash at the bases of the trees. In the plots where the soil was not removed from about the trees, and the wash was applied over a cotton batting band placed around the trunk at the soil level, the results were unsatisfactory. The paper collars reduced the efficacy of the washes slightly, the treatments being more effective when used with a protective wash at the base of the tree. The mixtures of naphthalene and paraffine proved more effective than the napthalene alone.

No injury to the trees was detected where the washes were applied in connection with paper collars or the protective wash.

PARADICHLOROBENZENE

Paradichlorobenzene was applied to prune trees at Creswell, Corvallis, and Salem. The applications of this material were made according

TABLE II. PARADICHLOROBENZENE TREATMENTS, 1922

One ounce of material applied per tree in each case

TREATMENT			RESULTS						
Locality	Date of application	No. of trees treated	Date results noted	No. of trees wormed	Trees infested with live worms Number	Trees infested with live worms per cent	Number of worms Alive	Number of worms Dead	Number of worms Alive per tree
Kiger Orchard, Corvallis..........	Aug. 19	14	Sept. 16	7	1	14	1[1]	15	.14
Skyline Orchard, Salem..........	Sept. 1	45	Sept. 13	15	4	26	4[2]	10	.26
do	do	do	Nov. 5	15	2	13	2	13	.13
do	do	do	Mar. 21	15	0	0	0	2	0
Woodward Orchard, Creswell.....	Sept. 6	45	Nov. 25	22	6	27	8	3	.36
do	Checks		do	5	4	80	8	0	1.60
do	Sept. 6	45	Mar. 23	22	0	0	0	3	0
do	Checks		do	8	3	38	3	0	.38

Small numerals indicate the numbers of larvae found on the trunk above the mounded soil.

to the methods used by eastern workers. The soil was leveled about the trees, and one ounce of the crystals was placed in a circle about two inches from the base of the tree. Soil was then mounded over the material and firmly packed. The dates of application and results of the treatments are indicated in table II.

TIME FACTOR. To be effective, it is necessary that sufficient time shall elapse after the application to permit of the volatilization of the crystals and diffusion of the gas about the base of the tree. It was found that when the results were noted in the fall, the number of living larvae varied inversely to the length of time that had elapsed since the application of the treatment. In no case were any living larvae found where the application was left undisturbed until the following spring.

POSITION OF LARVAE. Larvae situated on the trunk of the tree above the level of the mounted soil are not affected by the paradichlorobenzene treatment. In some orchards of western Oregon this constitutes a distinct disadvantage in the paradichlorobenzene treatment. Young larvae in superficial tunnels below the soil level are the first to succumb to the fumes. Large larvae in deep tunnels are more resistant, but larvae situated in deep tunnels as far as six inches below the level of the application were eventually killed. Larvae above the level of the application but below the level of the mounded soil were also killed.

INFLUENCE OF SOIL TYPE. It was found that the type of soil had considerable influence upon the action of the material. Most of the orchards of western Oregon are on heavy soils, varying from silt loam to heavy "gumbo." It was found that on the heavier soils, volatilization and consequently the lethal effects of the paradichlorobenzene were much less rapid than on the lighter soils. In the Skyline Orchard this was especially well illustrated. Where the material was applied in clay loam, approximately one-half of the crystals remained at the end of twelve days; while in a lighter silt loam in the same orchard the crystals had almost entirely disappeared at the end of the twelve day interval. So far as we have observed, none of the material has remained in crystalline form throughout the winter. However, in examining trees which had received a fall application, a faint trace of the characteristic odor could sometimes be detected in the spring.

INJURY TO PRUNE TREE. In no case was injury observed where one ounce of paradichlorobenzene was properly applied to healthy, mature prune trees, even though the material was allowed to remain undisturbed throughout the winter.

In some cases the treatment apparently hastened the death of trees weakened by infections of crown rot or root rot fungi.

Where excessive amounts of the material were used or where the material was placed in direct contact with the bark of the tree, severe injury resulted.

Applications of one-half ounce made to one and two-year-old prune trees resulted in the death of the trees in some instances, and we consider the application dangerous to trees of this age.

VICE-PRESIDENT S. B. FRACKER: The next paper is by D. M. DeLong and A. A. Mathewson.

THE HOUGHTON GOOSEBERRY APHIS (*MYZUS HOUGHTONENSIS*) AS A PEST IN OHIO

By D. M. DELONG and A. A. MATHEWSON, *Columbus, Ohio*

ABSTRACT

The Houghton Gooseberry Aphis injures gooseberries by forming leaf galls. The leaves are stunted, tightly curled and soon die. Very little fruit is produced and it is inferior in quality. The gall gives rise to a witch's broom by the formation of numerous abnormal shoots. The insect overwinters as an egg on the canes. The eggs begin hatching early in April. The first winged generation appears about the middle of May and migration takes place. They become re-established on the gooseberry and several wingless generations are found here during the summer and autumn. A second winged generation is produced in late October and the eggs are deposited a little later on gooseberry. This insect may have an alternate food plant but is able to survive normally on gooseberry alone.

Various workers in several of the eastern states have reported the Houghton Gooseberry Aphis since its description in 1909, as an insect affecting gooseberries. Very little data has been given however in regard to the degree of injury and its effects upon the plant. Also certain rather interesting and important phases of the life-cycle have not been previously reported.

Attention was called to this problem some months ago when a grower made inquiry regarding the best control measure for this pest. His inquiry was accompanied by the statement that he owned a five acre planting of Houghton gooseberries in western Ohio which was so severely injured or destroyed by this aphid that a commercial crop of fruit could not be produced and it would be necessary to remove these canes if an adequate control measure could not be found. Upon investigation this insect was found to be causing severe injury to small as well as larger plantings and a study of its life cycle and injury were undertaken.

The injury is very conspicuous, since the insect causes the formation of a leaf gall, frequently spoken of as the witch's broom. The galls are composed of many small, stunted, tightly curled leaves and may vary in size from one-fourth of an inch to two or three inches in diameter, depending upon various conditions, chief of which are weather and abundance of individuals. The curling of the leaves is so pronounced that it is very difficult to make life cycle observations, since the insects are so completely secluded. The first seasonal galls are produced by the first nymphs hatching in the spring and each generation continues to produce new galls throughout the summer. After the formation of the galls, the leaves are soon killed, turn brown and remain on the plant for some time. The last galls formed in the autumn usually remain on the plant during the dormant season. During the development and growth of the gall this portion of the plant is apparently stimulated to produce certain definite types of growth. As has been mentioned previously, the first conspicuous change from a normal growth condition, is the formation of a large number of stunted curled leaves. The next condition following the leaf gall is the formation of the witch's broom which is caused by the gall giving rise to a large number of new shoots. Thus wherever there is a gall, a large number of unhealthy dwarfed shoots are formed which produce only a small amount of inferior fruit, instead of the normal condition of each branch producing a few healthy shoots. The vines are injured in this way very noticeably because of insufficient numbers of normal healthy canes and normal leaves, and the fruit production is decidedly reduced because of the condition of the shoots that form the fruit buds. This loss is more apparent when it is known that sixty-five or seventy galls may occur on a single plant.

Life History Notes

Many details of the life cycle cannot be given at this time, but continued observations have shown certain definite relationships with the host throughout the season.

The aphid overwinters as a shining black egg about 1 mm. long which is deposited near the ground on the lower limbs and canes. They may be placed on the bark, buds, old leaves or thorns but are usually on the lower portion of the canes. As many as ten or twelve eggs are frequently placed inside the bud scales and form the galls on the new leaves as they push out from the bud. During the past season the eggs began hatching at Columbus about April 10th when the buds were bursting, and galls were formed from the first opening leaves before they

1. A typical infested plant, showing number of galls to a single plant; 2. Appearance of a small gall; 3. Portion of a single branch with typical large galls; 4. and 5. Eggs deposited on bud. Note green leaves at tip beginning to grow; 6. Old gall with numerous shoots arising from injured portion.

had attained any size. Although the galls soon appear on all parts of the plant, they are especially abundant on the new young canes which are only a few inches above the ground. The wingless females continue to give birth to living young and form new galls until about May 17, when the winged females appear and begin migrating. This migratory period continues for three or four weeks at the end of which time no aphids could be found in the galls. For about three weeks scarcely an aphid could be found on the gooseberry plants. During the latter part of June the young aphids were again found on the gooseberries forming galls upon laterals and terminals. A series of wingless generations was then produced throughout the summer and autumn. During this time at least eight generations were observed and these continued to produce galls which practically covered the plants. This rapid multiplication continues until late October when a second winged generation is produced upon the gooseberry which either deposits the overwintering eggs or produces wingless females which deposit them. In some cases where winged females were confined to cages, eggs were deposited on the canes and no wingless forms could be found. On the other hand mounted winged females seem to exhibit wingless forms within the body. The writers are therefore in doubt regarding this point. Deposition of these eggs continues in the field until November 25th (1923).

In view of these rather brief life history notes, certain conclusions are quite obvious. First, the insect can and normally does live upon the gooseberry throughout the entire growing season in injurious numbers. Second, two winged generations are produced annually on the gooseberry, the autumn generation apparently depositing the overwintering eggs on the same food plant. Third, although the insect may have an alternate food plant upon which it spends a portion of its life cycle, all evidence points to a change in the specific plant of the same host only, and not to a change of alternate hosts during the winged stage.

Natural Enemies and Control

The only natural enemies that have been found during this study were the larvae of some of the smaller syrphid flies. They were present during a part of the summer in sufficient numbers to interfere seriously with breeding work. At certain times during the summer these larvae were so abundant that only a few aphids could be found on examination of a large number of galls. At other times the aphids were very abundant and the natural enemies quite scarce. Because of this fluctuation

it is impossible to predict the amount of benefit derived from this source of biological control.

Although experimental work is now in progress to determine a good chemical control, no adequate control measure has been devised to date and further work is necessary before presenting any data upon this subject.

VICE-PRESIDENT S. B. FRACKER: The next paper on the program is by T. J. Headlee.

CERTAIN DUSTS AS AGENTS FOR THE PROTECTION OF STORED SEEDS FROM INSECT INFESTATION

By THOMAS J. HEADLEE, Ph.D., *Entomologist, N. J. Agricultural Experiment Stations*

ABSTRACT

Common white edible beans are protected from later attack by the common bean weevil (*Bruchus obtectus*) when mixed in proper proportions with ground burned lime (CaO), hydrated lime Ca $(OH)_2$, calcium chloride $CaCl_2$, calcium sulfate $CaSO_4$, dolomite, Highland Clay, Bond D Clay and Milltown Ball Clay No. 9. The protection which is afforded by these materials is most marked in the case of Milltown Ball Clay No. 9, and seems not to be connected with atmospheric moisture or chemical state of the dust materials. The protective ability of these materials appears to be correlated with the degree to which they exhibit a colloidal character—the more colloidal the more effective, the less collodial the less effective. This physical character seems to operate through preventing the larva of the bean weevil from obtaining sufficient foothold upon the surface of the bean seed to drill its way into the bean. Milltown Ball Clay No. 9, which is the most colloidal of all the dust materials worked with, appears to afford protection to wheat and shelled corn from later attack by the angoumois grain moth (*Sitotroga cerealella*). This clay apparently also has an insect reducing power when not in direct contact with the immature stages of the insects themselves. This insect infestation reducing power appears both in the case of the bean weevil and the angoumois grain moth.

DUSTS AS INSECTICIDES

Chambers pointed out that maize commonly protected from weevils by mixing the grain with finely powdered wood ashes. He noted that the layer of wood ashes on the outside of the sack alone was effective. The editor of the publication, in which Chambers' article appeared stated that a layer of building lime on the floor of the storing place and between successive layers of bags gives satisfactory results.

Metcalf[2] pointed out that mixing air-slaked lime with cow peas in

[1]Chambers, F. Rhodesia Agr. Journal No. 3, p. 397–398. 1916. 1. c. p. 398.
[2]Metcalf, Z. P. Journal of Econ, Ent. Vol. 10. p. 74–87, 1917.

certain proportons resulted in a large measure of protection from the ravages of the bean weevils.

TABLE 1.[3] EFFECT OF MIXING VARIOUS DUSTS WITH DRY COMMON, WHITE BEANS WHEN THE CULTURE IS PROMPTLY SEEDED WITH 5 ADULT BEAN WEEVILS (BRUCHUS OBTECTUS) TEMPERATURES 80° F. AND HUMIDITY 73.4%

Proportion by weight Beans	Substance	Adults start	CaO Holes	$CaCl_2$ Holes	$Ca(OH)_2$ Holes	Milltown Ball Clay No. 9 Holes
32	1	5	30		66	
16	1	5	0	1	5	0
8	1	5	0	0	0	0
4	1	5	0	13	0	0
2	1	5	0	0	1	0
1	1	5	0	0	1	0

Thus it appears the mixing of common, white, edible beans with ground burned lime (200 mesh) (Calcium chloride (mostly 200 mesh), hydrated lime (mostly 200 mesh or finer), and Milltown Ball Clay No. 9 (200 mesh) in various proportions gives protection in the lower dilutions, ground burned lime and the clay giving the best results with the higher dilutions.

TABLE 2. EFFECT OF PLACING VARIOUS DUSTS IN THE SAME CONTAINER WITH BEANS SEEDED TO COMMON BEAN WEEVIL WHEN THE BEANS AND THE WEEVILS ARE SEPARATED AND FULLY PROTECTED FROM CONTRACT WITH THE DUSTS BY A THICK LAYER OF ABSORBENT COTTON. TEMPERATURE 80°F AND HUMIDITY 73.4%

Proportion by weight Beans	Substance	Adults start	CaO Holes	$CaCl_2$ Holes	$Ca(OH)_2$ Holes	Milltown Ball Clay No. 9 Holes
4	1	15	50		257	
2	1	15	14	50	184	27
1	1	15	0	4	147	0
1	2	15	0	24	10	0
1	4	15	0	0	199	0
Control			60			

This table shows that ground burned lime (CaO) and clay have a decided protective effect even when not in contact with the beans.

[3]Throughout tables 1 & 2 each hole represents a distinct chamber from which the new beetle had already or not at that time emerged.

TABLE 3. EFFECT OF MIXING MILLTOWN BALL CLAY NO. 9 (200 MESH) WITH COMMON WHITE BEANS IN VARIOUS PROPORTIONS AND SEEDING EACH GROUP WITH 25 ADULT BEAN WEEVILS. TEMPERATURE 80° F. AND HUMIDITY 73.4%
(NOV. & DEC. 1921)

Composition of the mixture		No. of Beans	No. infested	No. of Holes
Parts of Clay by weight	Parts of Beans by weight			
1	1	440	0	0
1	5	446	0	0
1	10	424	0	0
1	15	440	4	17
1	20	430	9	27
1	30	436	8	23
1	40	438	9	22
1	50	432	13	32
1	70	427	16	36
1	90	434	12	17
1	100	440	18	30
Check		426	86	86

Thus it appears that this clay affords complete protection when used at the rate of 1 part of clay to 10 parts of beans by weight.

In an effort to see what effect this clay would have against the angoumois grain moth (*Sitotroga cerealella*) on corn and wheat, mixtures of it and these grains were made. An ear of corn was rotated in the clay dust, placed in a jar and subjected to infestation by several pairs of moths. In due time a reasonably heavy infestation resulted.

Shelled corn was then tried and the results are shown in table 4.

TABLE 4. EFFECT OF MIXING MILLTOWN BALL CLAY NO. 9 (200 MESH) IN VARYING PROPORTIONS WITH SHELLED, YELLOW DENT CORN. TEMPERATURE 80° F. AND HUMIDITY 73.4% (1922)

Composition of Mixture		Period in days from introduction to exam.	No. of moths introduced	No. of moths at end	No. of corn grains	No. of corn grains infested
Parts of clay by weight	Parts of corn by weight					
1	1	29	4	4	153	0
1	5	26	4	4	160	0
1	10	24	4	4	149	0
1	15	32	4	4	154	0
1	20	32	4	4	154	0
1	30	36	2	2	148	0
1	40	36	2	2	149	0
1	50	32	2	2	152	0
Check		40	2	68	150	68

Thus it appears that Milltown Ball Clay No. 9 affords protection to shelled corn when mixed with the corn at the rate of one part of the

clay to 50 parts of corn by weight. This study does not show the minimum dosage.

The effect of mixing Milltown Ball Clay No. 9 with wheat and then examined and the results are set forth in tables 5 and 6.

TABLE 5. EFFECT OF MIXING MILLTOWN BALL CLAY NO. 9 (200 MESH) WITH WHEAT AND SEEDING WITH ONE AND TWO PAIRS OF THE ANGOUMOIS GRAIN MOTH. TEMPERATURE 80° F. AND HUMIDITY 73.4% (1922).

Composition of the mixture: Clay in parts by weight	Wheat in parts by weight	Days from introduction to examination	No. of moths introduced	found	No. of wheat grains	No. of grains infested
1	1	29	4	4	1300	0
5	1	28	4	4	1300	0
10	1	30	4	4	1300	0
15	1	32	2	2	1300	0
20	1	33	2	2	1300	0
30	1	35	2	2	1300	0
40	1	35	4	4	1300	0
50	1	36	2	2	1300	0
Check		44	4	72	1300	48

TABLE 6. EFFECT OF MIXING MILLTOWN BALL CLAY NO. 9 WITH ALREADY INFESTED WHEAT. TEMPERATURE 80° F. AND HUMIDITY 73.4% (1922)

Composition of the mixture: Parts of Clay by weight	Parts of Clay by weight	No. of moths emerging	No. of parasites emerging
4	1	2	2
3	1	3	0
2	1	6	0
1	1	4	0
1	2	3	0
1	3	8	0
1	6	5	1
1	8	9	5
1	16	12	0
Check		5	26

Thus it appears that mixing wheat with Milltown Ball Clay No. 9 at the rate of 50 parts to one by weight affords perfect protection. The minimum dosage did not appear in this study. It further appears that comparatively large dosages of clay slightly reduced the infestation itself.

From the data recorded in tables 1 and 2 it seems obvius that when common white beans are mixed with ground burned lime (CaO), Calcium chloride ($CaCl_2$), hydrated lime ($Ca(OH)_2$) and Milltown Ball Clay

No. 9 they are more or less protected from later infestation by the common bean weevil. It also seems that of the four substances enumerated ground burned lime (CaO) and Milltown Ball Clay No. 9 are most effective and give, at certain dilutions, perfect protection. Unfortunately, ground burned lime causes the seed to crack and fortunately Milltown Ball Clay No. 9 leaves the bean in an apparently perfect physical condition.

The data submitted in tables 3, 4, 5, and 6 indicate that Milltown Ball Clay No. 9, when mixed with common white beans, at the rate of one to ten will afford apparently perfect protection from later common bean weevil attack and, when mixed with shelled corn or wheat at the rate of at least one to fifty, will afford apparently perfect protection against subsequent angoumois grain moth attack. Most surprising of all, the data in tables 2 and 6 indicates that even when not in direct contact with the insect the clay is capable of exerting a reduction of infestation.

Relative Humidity

Prevention of common bean weevil attack on common white beans in storage by the maintenance of a low relative humidity, as set forth by Headlee,[4] when connected with Chambers' and Metcalf's experience, seem to indicate that the dusts tried at that time were acting through the maintenance of a low relative humidity, but when it was found[5] that the hygroscopic power of calcium hydroxide and Milltown Ball Clay No. 9 was extremely low and at the same time that they were effective insecticides against the common bean weevil, that idea had to be deserted.

Chemical Composition, Acidity and Alkalinity

An effort was then made to determine whether chemical composition, acidity or alkalinity had anything to do with protecting common white beans from infestation by the common bean weevil. All materials were ground to the same fineness (200 mesh). Four different kinds of material were used. Their composition, pH value and organic content are set forth in the following table:—

[4]Headlee, Thomas J. Journal of Econ, Ent. vol. 10 p. 34–37.
[5]Headlee, Thomas J. Report of N. J. Agr. Exp. Sta., year ending June 1921 p. 370–371.

TABLE 7.

No.	Name of Carrier	SiO_2 %	Fe_2O_3&Al_2O_3 %	CaO %	MgO %	pH	Loss on ignition
1	Highland Clay	52.59	33.25	0.95	0.22	7.5	10.50
2	Bond D Clay	68.00	21.90	0.30	0.20	7.0	8.00
3	Mill town Ball Clay No. 9	63.30	13.80	0.22	0.16	4.7	10.88
3A	Milltown Ball Clay	63.30	13.80	0.22	0.16	4.7	10.88
4	Calcium sulfate	0.02	0.00	41.14	0.00	7.5	
5	Sea Sand	98.04	1.02	0.03	0.40	7.0	0.70

These same materials were mixed with common white beans and seeded with ten adult beetles each. The results are set forth in the following table:—

TABLE 8.

No.	Acid reaction	Alkaline reaction	Neutral reaction	Material used Dust	Amt. beans grms.	Amt. Dust grms.	No. of beans penetrated	No. of Adults
1		+		Highland Clay	10	1	none	10
2			+	Bond D Clay	10	1	none	10
3	+			Milltown Ball Clay No. 9	10	1	none	10
3A	+			Milltown Ball Clay No. 9	10	1	none	10
4	+			Calcium sulfate	10	1	24	68
7	Check				10		18	77
8	Check				10		22	80

Thus it seems obvious that chemical composition, acidity and alkalinity have little, if anything, to do with the effectiveness of the dusts when used in comparatively low dilutions (one part of dust to ten parts of beans).

PHYSICAL CHARACTERS

The physical characteristics of the dusts were next examined. The clays were, of course, more colloidal than either the calcium sulfate or the sea sand. A study of the comparative colloidal character of the three clays used is set forth in the following table, which serves to show that Milltown Ball Clay No. 9 is the most colloidal of them all:

TABLE 9.

No.	Carrier	Flocculation measured by transparent liquid	Flocculation measured by sedimentation	Turbidity measured by residue in soil suspension (salts included)
1	Highland Clay	2	16	124
2	Bond D Clay	2	65	242
3	Milltown Ball Clay No. 9 mesh	2	75	246

TABLE 10.* EFFECT OF THE SIZE OF THE PARTICLE ON THE EFFECTIVENESS OF CERTAIN DUST MATERIALS

Dilution in parts by weight		Milltown Ball Clay No. 9 No. of exit holes					Highland Clay No. of exit holes					Bond D Clay No. of exit holes				
Clay	Beans	80 mesh	100 mesh	140 mesh	200 mesh	270 mesh	80 mesh	100 mesh	140 mesh	200 mesh	270 mesh	80 mesh	100 mesh	140 mesh	200 mesh	270 mesh
1	5	0	0	2	0	0	0	0	0	17	0	0	0	0	0	0
1	10	0	0	0	0	0	12	0	0	0	0	0	0	0	0	0
1	20	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0
1	30	0	0	0	0	0	1	14	0	0	0	0	9	0	0	0
1	50	0	0	0	15	0	9	23	1	0	0	3	7	6	0	35
1	60	0	0	0	0	0	153	64	0	2	0	24	9	0	0	3
1	70	0	0	0	0	0	21	59	9	0	0	2	57	10	2	0
1	80	0	0	0	0	0	9	5	47	0	4	0	12	0	0	0
1	90	0	0	0	0	0	1	0	14	0	1	12	44	25	4	16
1	100	0	0	0	0	0	39	0	0	0	6	0	53	0	16	0
1	500	5	0	0	0	12	1	43	1	0	1	23	6	26	1	1
Check		154	28	39	118	92	122	21	177	105	43	58	195	34	105	58
		Hydrated Lime No. of exit holes					Land Plaster No. of exit holes					Dolomite No. of exit holes				
		80 mesh	100 mesh	140 mesh	200 mesh	270 mesh	80 mesh	100 mesh	140 mesh	200 mesh	270 mesh	80 mesh	100 mesh	140 mesh	200 mesh	270 mesh
1	5	23	0	28	4	21	0	30	25	1	0	2	0	0	0	0
1	10	22	0	2	12	22	5	34	49	6	0	20	4	0	16	1
1	20	25	11	5	36	59	0	56	7	3	0	7	11	16	4	0
1	30	18	34	0	40	3	7	11	84	19	0	2	0	7	17	0
1	50	33	90	26	120	53	74	110	134	0	7	0	24	4	50	0
1	60	101	27	15	102	126	101	103	132	17	12	51	30	0	54	17
1	70	153	52	124	38	163	17	33	53	62	21	7	24	18	75	58
1	80	33	25	35	96	78	1	99	5	17	0	0	0	30	13	9
1	90	218	12	84	159	148	6	77	48	9	3	60	15	80	25	40
1	100	122	0	49	162	92	12	13	7	55	15	11	6	9	37	51
1	500	166	27	20	173	22	28	128	62	62	57	42	105	39	61	12
Check		172	80	160	235	67	56	160	241	105	66	133	120	147	77	123

*Each culture was seeded with 10 adults of the common bean weevil and was kept during the summer at room temperature, changing to the constant of 80° F. when the necessity for artificial heat in the building arrived. The beans were the common white variety. An exit hole represents a new adult.

Calcium sulfate approaches the crystalloidal stage and sea sand is strictly a crystalloid. Examination of table No. 8 shows that while the clays in a dilution of one part to ten parts of common white beans gave perfect protection, calcium sulfate, in the same dilution did not effect anything like perfect protection.

The physical character of a dust material depends upon the physical character of the unit particles composing it and a study of the effect of different sized particles of Milltown Ball Clay No. 9, Highland Clay, Bond D Clay, Calcium hydrate, calcium sulfate and dolomite on the efficiency of dusts composed of these materials in preventing infestation of comomn white beans by the common bean weevil was undertaken. The following table will serve to set forth the results.

Of all the six dusts experimented with Milltown Ball Clay No. 9 is, without doubt, the most efficient, and 100 mesh material is apparently composed of the best size of particle.

Method by Means of Which Infestation is Prevented

Time has forbidden the study of the method by means of which infestation is prevented from including more than the common bean weevil on common white beans. Previous investigations had shown[6] that eggs were laid and that the eggs hatched but that no infestation took place.

For the purpose of discovering how the dusts kill the larvae a series of intensive observations were made on certain newly hatched larvae and the results are set forth in tables 11 and 12 and in the paragraph which immediately follows them.

Table 11. Record of One Just Hatched Larva which, when Just Out of the Shell, was Surrounded by a dust Ring of Milltown Ball Clay No. 9. Ring One-quarter of an Inch in Diameter

Time of observation 3–28–'23		Larval Activity
1:00	P. M.	Hatching completed
1:00–2:10	"	Remained attached to bean by caudal and moved body from side to side.
2:10–2:20	"	Moved in a complete circle within dust ring
2:20–2:35	"	Continued to crawl about with'n dust ring.
2:35–2:55	"	Repeatedly tried to crawl forward but seemed unable to grapple the surface of the bean because its holdfasts slipped.
2:55–3:20	"	Continued to crawl about within the circle of clay dust
3:20–3:40	"	Attached its caudal end and moved its body to and fro.
3:40–3:45	"	Crawled slowly about within the dust ring.
3:45–3:50	"	Caudal end attached to bean surface, body moved to and fro.
3:50–4:00	"	Caudal end attached but body quiet.

[6]Headlee, Thomas J. Rep't. N. J. Agr. Expt. Sta. for 1922.

4:00–4:10	"	Crawled about within the dust ring.
4:10–4:20	"	Larva crawled off the bean and fell into clay dust in the bottom of the chamber.
4:30	"	Replaced on the bean.
4:30–6:00	"	Caudal end attached, body moving to and fro.
3–29–23		
7:30	A. M.	Larva dead at the spot where it was left at 6:00 P. M. the preceding day.

TABLE 12. RECORD OF TWO JUST HATCHED LARVAE EACH PLACED ON A BEAN AND SURROUNDED BY A DIRT RING ABOUT ONE QUARTER OF AN INCH IN DIAMETER. LARVA NO. 1 WAS SURROUNDED BY A RING OF MILLTOWN BALL CLAY NO 9 DUST AND LARVA NO. 2 BY A RING OF HYDRATED LIME.

3–29–'23		
1:45	P. M.	Larvae placed.
1:45–2:15	"	No. 1 larva crawls about within the dust ring.
1:45–2:00	"	No. 2 larva crawls about within the dust ring
2:15–2	"	No. 1 larva stops crawling
2:00	"	No. 2 larva looks as if it were trying to drill into the bean
2:30	"	No. 1 larva pushes into the dust ring
2:30	"	No. 2 larva pushes into the dust ring.
3:00–4:30	"	No. 1 & No. 2 larvae so covered by dust that they can hardly be seen.
4:30–5:00	"	No. 1 & No. 2 larvae moving under the dust
3–30–'23		
8:00	A. M.	No. 1 & No. 2 larvae dead at the points where they were observed at 5:00 P. M. the preceding day.

On April 5, 1923 a larva was observed drilling into a bean where the bean surface lay adjacent to another bean. One and one-half hours were required for the larva to bury itself in the bean. In this instance the beans had not been treated with dust of any kind.

The writer's observations indicated distinctly that the larva was unable to grapple the bean surface because of the slipping of the fine particles of dust which its claws, and frequently its anal sucker seized upon. In fact, in many instances the writer saw the larva extend the front end of its body, attempt to lay hold of the bean surface and pull the caudal end forward. In most cases the front end simply slipped backward without, in any way, lifting the caudal end. Likewise, he observed that the front end would sometimes become seated, the anal would be pressed down on the surface of the bean, and an attempt made to shove the front end forward. In most of these instances instead of the front end going forward the anal sucker slipped backward.

In view of these observations, the writer believes that the inability of the larva to enter the bean which has been coated with a dust is due to its inability to grapple the surface of the bean firmly enough to give it a

foothold. The larva slowly wears itself out and died before it is able to penetrate.

Unfortunately the above recorded data fails to show clearly just why Milltown Ball Clay No. 9 exerts a destructive effect when not in immediate contact with the larvae or pupae of the bean weevil and angoumois grain moth. So far as the writer can see, there is nothing in the known chemical or physical composition of Milltown Ball Clay No. 9 that would account for its ability to destroy immature forms of the common bean weevil or angoumois grain moth, when not in contact with them, except possibly radio-activity. The material is somewhat radioactive.

Effect of this material upon germination or upon the milling and baking has not been determined.

MR. H. F. DIETZ: I would like to ask if this treatment has any effect on the milling quality of the wheat?

MR. T. J. HEADLEE: None that we can determine.

VICE-PRESIDENT S. B. FRACKER: The next paper is by T. L. Guyton.

NOTES ON THE USE OF CHLORINE GAS AS AN INSECTICIDE

BY T. L. GUYTON, *Penna., Bureau Plant Industry*

Trials in the use of chlorine gas as an insecticide in the control of the Angoumois grain moth (*Sitotroga cerealella*) resulted in the loss of germination to the treated wheat and an incomplete kill of the moths. In one case where the grain had a moisture test of 17% the treatment resulted in the charring of the treated sample.

An agent of the Electro Bleaching Gas Company called the writer's attention to the possibility of using chlorine gas as an insecticide in the control of the Angoumois grain moth and offered to furnish a tank of the gas for trial.

On December 1922 some wheat was obtained in the vicinity of Carlisle, Penna., just as it came from the thrashing machine, and another sample was obtained from a flour mill nearby. The sample obtained from the thrashing machine was heavily infested with the moth. The wheat weighed only thirty-six pounds to the bushel, had a moisture content of seventeen per cent and a germination test of sixty-nine per cent. The wheat from the mill weighed fifty-six and three-tenths pounds to the

bushel and gave a moisture test of eleven and nine-tenths per cent and a germination test of 91%.

A glass jar holding about one-half bushel was filled level full of wheat taken from the mill. A rubber hose was passed from the chlorine tank to the bottom of the jar. The gas was allowed to run into the jar until the presence of the gas was decidedly noticeable at the top. Time required was 28 minutes. Eight samples were taken at intervals of five, ten, fifteen, thirty, and sixty minutes, three hours, four hours and twenty-two hours. After removal from the fumatorium the samples were aerated by pouring from one vessel to another several times in the presence of a breeze.

An attempt was made to repeat the operation, using the wheat taken from the thrashing machine the previous day. The gas was turned on and strips of paper saturated with ammonium hydroxide were placed as indicators on the top of the grain. After the flow has continued about one hour no chlorine could be detected at the top of the jar. but the jar was quite warm, on the sides near the bottom. The gas was at once shut off. Upon examination the wheat in the bottom of the jar was found completely charred and there was a distinct odor of hydrochloric acid. (The jar was undisturbed for a few hours and then examined. The wheat was entirely ruined).

Control in first lot.

. The samples taken were placed in a dark, warm cupboard. On January 2nd, 1923, the five, ten and fifteen minute samples contained living moths. Moths continued to emerge from these samples. On January 29th all the samples contained some living moths.

Effect on germination.

Check sample gave a germination of	91%
Five minute sample gave a germination of	26.5%
Ten minute sample gave a germination of	29.5%
Fifteen minute sample gave a germination of	17.0%
Thirty minute sample gave a germination of	16.5%
Sixty minute sample gave a germination of	12.5%
Three hour sample gave a germination of	7. %
Four hour sample gave a germiniation of	11.5%
Twenty-two hour sample gave a germination of	10.5%

President Ruggles resumes the chair.

PRESIDENT A. G. RUGGLES: The next paper is by W. E. Britton.

AN ASIATIC BEETLE (*ANOMALA ORIENTALIS*) IN CONNECTICUT

By W. E. Britton, *State Entomologist, New Haven, Conn.*

ABSTRACT

Specimens of *Anomala* collected in a nursery in New Haven in 1920 and 1921 were identified in May, 1922, as *Anomala orientalis*. In 1923, white grubs injured the roots of grass in lawns in the vicinity. Adults were reared and proved to be this species.

On July 16 and 29, 1920, and July 26, 1921, Messrs. M. P. Zappe and B. H. Walden, Assistant Entomologists, collected on weeds and grass in a nursery in New Haven, some beetles which they recognized as belonging to the genus *Anomala*, but differing from any speices in the Station collection. At that time Mr. Charles Schaeffer of Brooklyn, N. Y., was engaged in studying the American species of *Anomala*, so we sent some of these specimens to him. He was unable to identify the newly-collected material, but stated that it was different from any American species that he has seen, and that probably it had been introduced from some other part of the world. Later he sent the material to the British Museum, where it was identified by Mr. Arrow. On May 17, 1922, I received from Mr. Schaeffer a letter reading as follows:—"He identified it as *Anomala orientalis* Waterhouse, a Japanese species, he tells me, which is reported as a destructive pest on sugar cane in the Hawaiian Islands. If it should get a good foothold here it may prove as injurious as *Popillia japonica* (the Japanese beetle) in New Jersey, also an introduced species."[1]

Late in the fall of 1922, one of my neighbors complained to me that white grubs were injuring his lawn and on November 2, I visited his place and collected a few specimens. At the laboratory we took them to be ordinary white grubs, though they were rather small and varied considerably in size and were quite active. These grubs all died, probably having injured each other with their mandibles, as we afterward learned they are apt to do when confined together with little soil .

The spring of 1923 had scarcely opened when other residents of the neighborhood also complained of similar injury to their lawns, and altogether perhaps a dozen such complaints were received. There were many lawns where the grass was entirely killed in patches eight or ten feet in diameter, and in other places a part of the grass still remained green. Now this neighborhood is in the same locality where the beetles

[1]See Journal of Economic Entomology, XV, 311, 1922: Report Connecticut Agricultural Experiment Station for 1922, 345, 1923.

were collected in 1920 and 1921, and we suspected that there might be some connection between them.

More larvae were collected but were at once separated so that they could not injure each other, and on July 24, 1923, adult beetles emerged. Prior to their emergence, specimens of the larvae were sent to the Bureau of Entomology at Washington, and identified provisionally as *Anomala orientalis* Waterhouse by Dr. A. G. Boving. The beetles reared here were at once recognized as the same as those which had been collected, namely, *Anomala orientalis* Waterhouse.

The locality where the collections were made was until two years ago a part of a nursery which several years ago imported many shipments of plants from Japan, and some of the plants came in balls of earth. This nursery has now removed to Woodmont, nearly six miles distant, and dwelling houses now occupy the land formerly covered with nursery stock. The infested lawns are not on the nursery grounds but across the street and extend for one or two squares northward and somewhat eastward from the point where the beetles were collected in the margin of the nursery.

The scouting which has been done indicates that the injured lawns are all in a residence section and within five or six city squares or blocks, but we do not know how widely this pest may have been distributed from the nursery, or how far the infestation may have spread beyond the area where injury is apparent, as a small number of grubs per square yard would not kill the grass, and therefore would not be noticed.

When this insect first appeared in Hawaii some ten years ago, it was so destructive to sugar cane that parasites were imported from Japan in the hope of controlling it. One of these, a Hymenopterous parasite, *Scolia manilae* Ashm., was established in Hawaii during the years between 1914 and 1915, and proved effective. From an area where in 1917, 3,500 *Anomala* grubs were collected, this parasite had so thoroughly reduced the pest by 1919, that by careful search only four grubs could be found. *Scolia manilae* is one of the parasites introduced into New Jersey on account of the Japanese beetle, but does not survive the winters. Consequently we can hope for little help from this insect, though there is a possibility that some of our native species of *Scolia* or *Tiphia* may attack the grubs.

The beetles do not seem to fly, but keep near the ground in the stubble or crawl upon the stems of grass and weeds. This habit is a distinct advantage where control measures are attempted.

Mr. E. P. Felt: I would like to ask if any attempt has been made to eradicate this new species.

Mr. W. E. Britton: We have carried on a few experiments in small areas to determine the best method of killing the grubs. The work is difficult, however, because there are many small yards that children are playing in and it is dangerous to use cyanide or similar poisons. The matter has been reported to the Federal Horticultural Board but no decision has been reached as to whether an attempt should be made to exterminate this insect.

President A. G. Ruggles: The next paper will be read by C. L. Corkins.

GRASSHOPPER BAITS, WITH SPECIAL REFERENCE TO SODIUM ARSENITE

By C. L. Corkins, *State Entomologist University of Wyoming*

Abstract

Experimental work with grasshopper baits was carried on over a period of three years with a two-fold purpose in view, first, to determine the merits, under Colorado conditions, of the ingredients commonly used in standard grasshopper baits; and second, to find a more practical killing agent than white arsenic.

Amyl acetate and salt are essential elements of an efficient grasshopper bait. A combination of bran, arsenic and water only, gave surprisingly good results, but not good enough for practical usage. The value of expensive molasses is doubtful. Only when cheap sugar beet refuse molasses can be obtained does it seem justifiable to include it. The substitution of 50% by bulk of sawdust in place of bran in baits to be used on lands of low productive value per acre, is recommended. Fermentation of the bait to replace the use of amyl acetate gave poor results when used for our economic species of *Acrididae* but excellent results in the case of *Anavrus simplex*.

The superiority of sodium arsenite over white arsenic was established by two years of experimentation and its extensive use in two large epidemics of grasshoppers. As a killing agent, it is fully as efficient as the best mixed white arsenic and is more practical in mixing, cost and handling.

(Withdrawn for publication elsewhere).

President A. G. Ruggles: We will now hear the next paper by R. C. Smith.

CAENURGIA ERECHTEA (CRAM) (NOCTUIDAE) AS AN ALFALFA PEST IN KANSAS[1]

By Roger C. Smith, *Kansas State Agricultural Experiment Station*

ABSTRACT

A common insect in alfalfa, clover and pastures of Kansas; occasionally numerous but not seriously injurious. The name "Forage looper" is proposed for it. Overwinters as a pupa and possibly as a partly grown larva. Three and a partial fourth generations annually. All stages described and biological data summarized. Natural enemies effective. Cutting alfalfa results in death of many of the larvae.

During the progress of a Kansas experiment station project on alfalfa insects, it was observed that *Caenurgia erechtea* (Cram.), better known as *Drasteria erechtea* Cram. was present constantly in alfalfa fields and occasionally in considerable numbers. It has been reported frequently in the literature as occurring in clover fields, but always as a minor pest. In Virginia, the writer observed this insect during two years in clover fields, but it was never seriously abundant. It was also very common in grass pastures and was known locally as the "grass worm."

Several common names have been proposed for this insect. Comstock (1917) suggests "Clover looping owlet moth;" Saunders (1875) the "Common Drasteria," and O'Kane (1912), the "Northern grass worm." All of these are open to objection and criticism in the light of later knowledge so the author proposes the name "Forage looper" because the larva has a looping gait, and all stages occur in pasture, grassy places, fields of clover and alffala. This name was submitted to the committee on nomenclature, and was approved by it.

The other well known species of Caenurgia, *crassiuscula* Haw. is very uncommon in Kansas. It was collected only a few times and was never reared. The larval characters are not known to the writer.

This is one of our common noctuids, and published records show the distribution to be the Atlantic states to Florida, west to British Columbia and California. It is apparently plentiful throughout its range. In Kansas it is occasionally the most abundant lepidopterous insect in alfalfa; therefore, considerable rearing and field observations were carried on for a period of four seasons. While not a major pest of the

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[1]Contribution No. 325, from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in Experiment Station project No. 115.

The writer wishes to acknowledge his indebtedness to certain undergraduate and graduate students in the field and rearing work. Chief among these is Mr. Edgar Davis who assisted especially in the rearing work and preparation of the tables. Further acknowledgment is made to Mr. S. Fred Prince for the drawings, to Dr. W. T. M. Forbes, the United States Bureau of Entomology for determinations, and the latter for Mr. Heinrich's work on the setal maps.

crop, it is one of the large group taking its toll from the crop and it may be of greater importance in the future.

The best published accounts of this insect are the papers of Saunders (1875), French (1884), Osborn and Gossard (1891), Slingerland (1892) and Webster (1898).

Seasonal History

The insect overwinters mainly as a pupa in a silken cell just under the surface of the ground or in a cocoon of silk and dried leaves at the base of the plant. Pupae have been dug up in the spring in overwintering cages and the moths emerged. While it is believed that the bulk of the overwintering forms are pupae, it is possible that half grown larvae may sometimes survive the winter, because a group of larvae lived in an outdoor cage from October 22, 1922, to the latter part of February, 1923. Partly grown larvae of this species can be collected in alfalfa fields by sweeping as late as December 1st, but it is believed they all or nearly all perish ordinarily before this date. The moths appear in the spring about the time alfalfa is beginning to grow.

The first moths were taken on March 31, 1922 and April 8, 1923. The second generation of moths appears at Manhattan about June 10. This is a light brood, and the larvae are always scarce during this period. The second brood reaches maturity about July 14th. The first of the third brood appears as adults about August 15. At this time and subsequently all stages occur in the fields and the broods overlap. These moths deposit eggs the latter part of August and during September. Some of the third generation pupae overwinter, others give rise to adults which deposit eggs for a partial fourth brood. There are thus three generations in Kansas of approximately a month's duration each and a partial fourth, the greater number of larvae of which succumb to the cold of November and December.

Life History

The length of life in the various stages in both indoor and outdoor rearings is shown in Table I.

The width of the head capsule and total length in the various stages of larvae are shown summarized in Table II.

Life Stages. This insect is easily reared, the usual rearing methods proving satisfactory. Eggs and pupae are not easily collected in the field, but are readily obtained in cage rearings. The egg (Fig. 11, 8) has been described by French (1884) and Riley (1885). They are

TABLE I. SUMMARY OF LENGTH OF STAGES IN THE LIFE HISTORY

Stage	Longest days	Shortest days	Average days	Number of Individuals Averaged
Egg	6	4	4.8	76
First instar larva	6	3	4.1	72
Second " "	6	2	3.0	70
Third " "	5	2	3.3	63
Fourth " "	6	2	3.7	52
Fifth " "	6	3	4.4	33
Sixth " "	7	3	5.2	15
Prepupa	9	1	2.7	13
Pupa (Summer)	13	10	11.4	8
Adult	23	0	13.5	54
Totals	87 days	30 days	56.1 days	

TABLE II. SUMMARY OF INSTAR MEASUREMENTS

Stage	Dimension	Greatest mm.	Least mm.	Average mm.	Number of Individuals Averaged
First instar larva	length	7	3.7	5.22	45
" " "	width of head	0.4	0.3	0.39	45
Second instar larva	length	11	6.	7.66	45
" " "	width of head	0.6	0.46	0.58	45
Third instar larva	length	17	8	12.2	39
" " "	width of head	0.93	0.66	0.83	39
Fourth instar larva	length	26	11	17.2	36
" " "	width of head	1.53	1.14	1.31	38
Fifth instar larva	length	34	18	26.3	27
" " "	width of head	2.0	1.66	1.89	28
Sixth instar larva	length	43	23	34	20
" " "	width of head	2.87	2.13	2.5	20

deposited singly or in groups on any part of the plant, but especially on the leaves.

As embryological development proceeds, the eggs become spotted with brown. These spots are irregular in shape, of different sizes and scattered irregularly, but their relative positions in different eggs are the same. The largest one is near the micropyle and is always present. Between these spots are numerous, conspicuous, whitish, flaky spots beneath the chorion. The larvae hatch by eating nearly circular holes in the egg shells 0.25 mm. in diameter. Upon emerging, the larvae generally devour a portion of the remaining empty egg shell. They may devour all but the attached portion of the chorion.

Larvae. They are longitudinally striped (Fig. 11, 3, 4, and 7) or banded, and walk with a looping gate. All stages may be readily col-

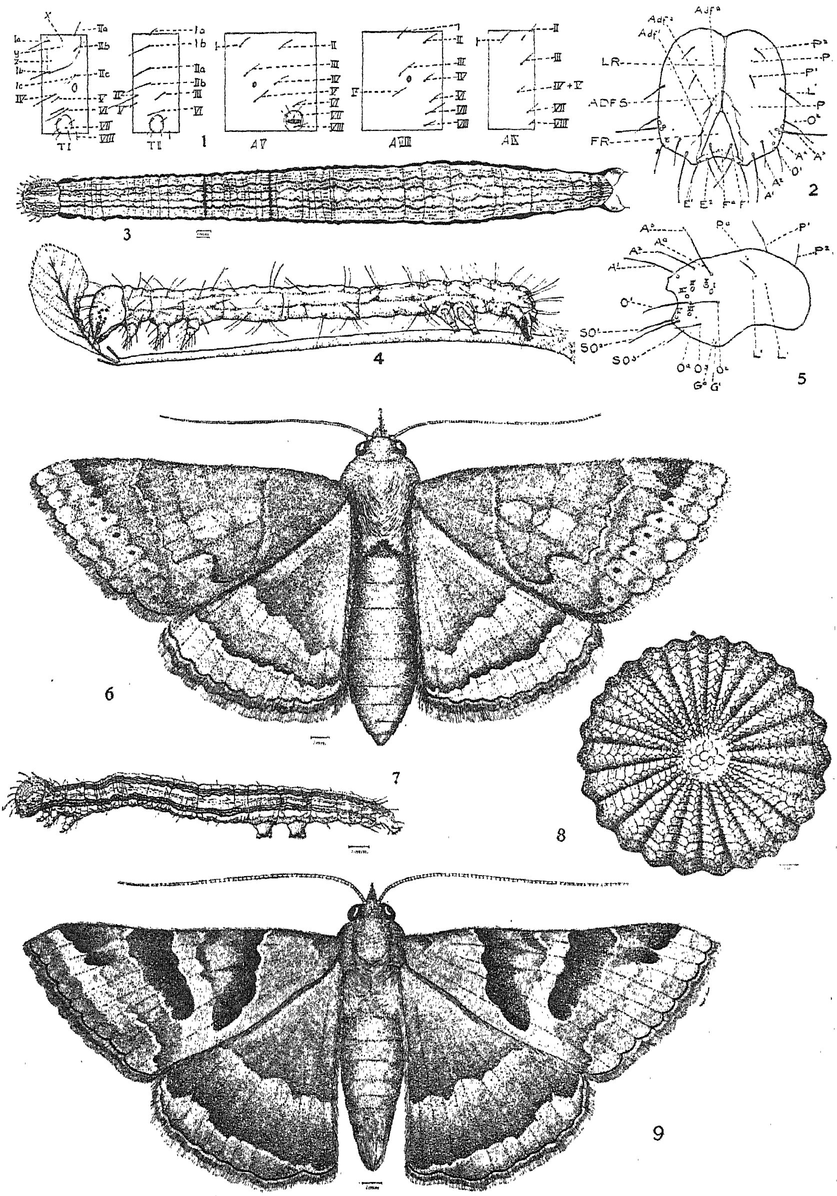

Fig. 11.—*Caenurgia erechtea* 1. Map of body setae mature larva; 2. Map of head setae, mature larva; 3. Color pattern of grown larva, dorsal view. Note two intersegmental darkened areas; 4. First instar larva; 5. Lateral view of head, setal map, 6. Female showing color pattern; 7. Lateral view of grown larva; 8. Dorsal aspect of egg; 9. Male showing color pattern. Most drawings, by Mr. S. Fred Prince; 1, 2 and 5 by Carl Heinrich.

lected by sweeping alfalfa with a net, while the large ones are sufficiently conspicuous as they rest extended along a leaf or stem to make possible their collection by hand. The larvae have been described as to coloration, size and general features by French (1884).

It is well known that color bands vary in number and shade; therefore, at the writer's request, Mr. Carl Heinrich of the U. S. National Museum prepared a description of setal characters which is given verbatum, accompanied by figures, 1, 2, and 5:

"Body cylindrical, slender, scarcely tapering at caudal end; abdominal segments much elongated. No secondary hair. Legs normal. Prolegs on 5th, 6th, and 10th abdominal segments only. Crochets uniordinal, in a mesoseries. Prothoracic shield narrow, undivided, not extended laterallyto include setae Ic to IIc. Spiracles oval, rather large; that on prothorax 2 times and that on 8th abdominal segment 1½ times as large as others on abdominal segments. Skin smooth.

Body setae short; tubercles very small with no surrounding chitinizations; IV on abdominal segments 1 to 8 posterior to the spiracle, far removed from V; V antero-ventrad of the spiracle on abdominal segments 8 and 1 to 4,directly ventrad on 5 to 7; only two prespiracular setae on prothorax (IV and V), III absent; IV and V united on abdominal 9; II antero-ventrad of the spiracle on abdominal segments 1 to 8, farthest forward on segments 1 to 4; IIIa not distinguishable; I and II nearly on a level on most abdominal segments, II distinctly more laterad, only on segments 7 and 8; group VI bisetose on prothorax, unisetose on remaining thoracic segments and on abdominal segments 1 to 8; absent on abdominal 9; group VII trisetose on abdominal segments 1 to 6, unisetose on 7, 8 and 9; prothorax with IIa higher than Ia, Ic and IIc closely approximate and well separated from the other setae, Ib also well separated, punctures X and Y well back of seta Ia, Y lying midway between Ia and IIb; meso- and metathorax with Ia and Ib well separated, also IIa and IIb.

Head capsule spherical; longer than wide; greatest width well forward of middle; incision of dorsal hind margin slight. Frons (FR) triangular, slightly longer than wide, not reaching middle of head. Adfrontal sutures (ADFS) extending to middle of head. Longitudinal ridge (LR) long, about 1½ times length of frons.

Ocelli six; lenses well defined; ocelli I to IV grouped together; V and VI well separated from the rest. Epistoma normal.

Frontal punctures (Fa) close together; slightly forward of frontal setae (F^1); distance separating frontal seta (F^1) and first adfrontal seta (adf^1) less than that separating adf^1 and adf^2 posterior to beginning of longitudinal ridge; puncture adf^a approximate to adf^2.

Epicranium with the normal primary setae and punctures, but without distinguishable ultra posterior setae or punctures. Anterior setae (A^1, A^2, A^3) forming an obtuse angle; anterior puncture (A^a) postero-laterad of A^2. Lateral seta (L^1) well back on head, widely remote from A^3; lateral puncture (L^a) postero-ventrad of L^1, approximate. Posterior setae (p^1, p^2) behind middle; puncture p^a before middle, on the level of adf^2; puncture p^b lying between p^1 and p^2. Ocellar setae (0^1, 0^2, 0^3) triangularly grouped; 0^1 lying close to and below ocellus IV; 0^2 postero-ventrad of ocellus 1, in a line with ocelli I and II;0^3 antero-ventrad of 0^2, remote; ocellar punct-

ure (O) lying between O^3 and ocellus VI. Subocellar setae (SO^1, SO^2, SO^3) triangularly placed and approximately equidistant; subocellar puncture not distinguishable. Genal seta and puncture (G^1, G^a) minute; puncture before the seta."

The larvae during the first and second instars eat the epidermis from the leaves while later instars skeletonize the leaves. The larger larvae, when abundant may entirely defoliate the plant. This was never observed in fields but often occurred in cages. The larvae hold fast by means of the abdominal legs, then reach out in all directions for food or support. When disturbed they curl up in a distinctive manner. The head and thorax are bent ventrad, bringing the venter of this region in contact with the venter of the abdomen. When not feeding, they usually remain fully extended and motionless on leaves or stems near the top of the plant.

In the early spring and late fall, especially the latter, the larvae are smaller and much darker colored. They are banded as during the summer, but there is more black and red in the bands. The larvae resemble rather closely, as to coloration, the larvae of *Laphygma flavimaculata* Harv. and *Diallagma angustiorata* Grt.

Pupa. After a minimum period of two weeks, the larvae are fully grown and make preparations for pupation. The larvae tie leaves, stems, earth or excrement together with silk, making a concealing cocoon in which they rest one or two days as prepupae. During this time the coloration becomes subdued, the body shorter and somewhat spindle shaped. The pupae are whitish, appearing as if a brown cocoon had become moldy or stained with a whitish coat, and are about 15 mm. in length. Pupae in the field sometimes occur among the leaves of the plant, but more commonly they are under the plant among the leaves and trash on the surface of the ground. Overwintering pupae are found below the surface of the soil, usually about two inches.

The Adult. The adult has been described and figured several times, but usually only the male is figured (except Webster, 1898, and Holland: Moth Book, pl. XXX, fig. 14). Since the coloration in the two sexes is so different, both are figured here (Figs. 11, 6 and 9). They are rather swift fliers and may be mistaken, especially the female, for the moth of the corn earworm (*Chloridea obsoleta* Fab.). When disturbed they fly swiftly a short distance, alighting on the upper sides of exposed leaves, low down on the plant or on the ground. Their flight is jerky and somewhat erratic. They are attracted somewhat to lights and various baits placed in cone traps. Vinegar and molasses was apparently more attractive than banana oil, molasses, sugar water, or water.

The moths can be kept alive in cages, usually without much difficulty, by feeding them dilute sugar water or placing in the cage a bouquet of alfalfa blossoms. The average length of life of fifty-four moths was 13.5 days. The longest period any moth remained alive was 27 days.

The maximum number of eggs obtained from any moth in these rearings was 588. The average of 25 moths kept under as nearly optimum conditions as could be provided was 181 eggs. Records of fifty to one hundred eggs deposited in one night by a single female were common, and above a hundred not rare. The largest number obtained from one individual in one night was 185. Nothing unusual or different from closely related moths was observed regarding oviposition or copulation.

The moths are largely inactive during the day, flying only when disturbed. They are active on cloudy days and in the evenings when they can be observed feeding at the blossoms of alfalfa and various weeds in alfalfa fields.

In the autumn and early spring, the moths are smaller and darker colored, a condition pointed out by Walsh and Riley (1869). These darker forms have been given the varietal name of *parva* by Blackmore (1920).

Natural Control

The eggs are parasitized by *Trichogramma minutum* Riley. Since eggs are so rarely found in the field, no definite data on natural parasitism is available Parasitism can be readily induced in the laboratory by exposing eggs one or two days old to the parasites. The eggs turn black and one to four adults emerge in about eight days through a hole gnawed in the side of the egg.

Larvae are parasitized by Tachinids. Relatively few adult parasites have been obtained, though efforts were made to rear a great many from parasitized larvae. *Winthemia quadripustulata* Wied. was obtained three times. Parasitism was never observed to be an important factor.

The larvae are subject to a bacterial wilt which kills many in salve box rearings. A somewhat lesser number succumbed in cage rearings. It was frequently observed in the field, but is apparently dependent on weather conditions.

Birds pick up these larvae along with other lepidopterous larvae in alfalfa. Among those observed to feed upon such larvae are grackles, robins, English and other sparrows. Certain Nabids and Reduviids,

especially *Nabis sp.* and *Sinea diadema* (Fabr.) were often observed to feed on small larvae and it is believed that they are the most important of the predacious enemies.

Artificial Control

During these observations, artificial control has never been necessary. It was observed in fields and cage experiments, however, that most larvae perish when the crop is mowed. The larvae may be killed by the heat in twenty minutes to an hour, during the hottest part of the summer. Generally, however, the larvae begin to migrate from the field and perish from heat, starvation, or are picked up by predacious enemies.

Late fall and early spring plowing of infested clover fields recommended by several writers is scarcely practicable in alfalfa growing.

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[The European Corn Borer papers were presented at this point in the program. They were published in the February issue, pp. 112–159, as directed by vote of the association. EDITOR.]

PRESIDENT A. G. RUGGLES: The next paper will be presented by J. W. McColloch.

THE TIME OF PLANTING CORN AS A FACTOR IN CORN-EAR WORM CONTROL[1]

By J. W. McCOLLOCH, *Kansas State Agricultural College*

ABSTRACT

Experiments which have been under way at the Kansas Station for ten years show that there is a definite relation between the date of planting corn and injury by corn-ear worm, *Heliothis obsoleta* Fabr., As a rule, the date of minimum ear worm injury and maximum yields coincide. The problem has been studied from several angles and these are discussed briefly in this paper.

In 1909 the Department of Entomology of the Kansas State Agricultural College began an investigation to determine the relation existing between the time of planting corn and the amount of corn earworm injury. Previous studies had shown that there was little hope of effecting a complete control of this insect, but that injury could be materially reduced by regulating the date of planting. The general plan of the experiment and the results of the first year were presented before this association in 1910[2] and it is the purpose of this paper to summarize the results obtained during the ten-year period 1909 to 1919.

PLAN OF THE EXPERIMENT

Each year this investigation was based on a series of five plots of corn planted at intervals of 15 days, beginning the middle of April. Three standard varieties of corn; namely, Boone County White, Kansas Sunflower, and Hildreth were grown in each plot throughout the experiment, and Commercial White was added in 1913. Each variety was planted in a three-row series, the rows varied from 100 to 200 feet in length during the different years, but were the same length each year, so the results are comparable. Plantings were made on April 15, May 1, May 15, June 1, and June 15. This experiment was conducted on the same area during the last eight years and the land was handled in the same manner as is usually followed by the average farmer. The rows

[1]Contribution No. 329, from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in project No. 9 of the Kansas Agricultural Experiment Station

[2]Headlee, T. J., Notes on the Corn Earworm. Journ. Econ. Ent., 3:149–157, 1910.

were 40 inches apart and the hills 36 inches. Shortly after coming up, the corn was thinned to two plants in a hill.

Presentation of Data

The problem of reducing earworm injury to corn by varying the date of planting involves a study of many factors. Because of the variation in climatic conditions and in the abundance of the insect in different years, any recommendations should be based on the average of a number of trials. The period covered by this study represents five good corn years, two fair years, and three years when the yields were very poor. From the standpoint of the abundance of the earworm, there were five years of severe injury, three of moderate injury and two when the infestation was light.

Data were taken on all phases of climatic conditions and plant growth which are associated with earworm activities. Since space will not permit of a full discussion of the data, emphasis is placed on the yields and the percent of ears injured, and the data relating to these two points are summarized in Table I. The results are also arranged to show the frequency with which maximum yields and minimum injury were obtained with relation to the date of planting.

An analysis of the data presented in Table I shows that, from the standpoint of maximum yield and minimum earworm injury, corn should be planted between April 15 and May 1 at Manhattan, Kansas. The plots planted May 1 show an average increase in yield over those of April 15 of from 3.4 percent in the case of Kansas Sunflower to 15.5 percent for Boone County White. At the same time there was a decrease in the number of ears injured of from 2.3 to 3.4 percent for all varieties except Hildreth. The yields of the May 15 plantings were from 3 to 5.5 percent lower than those of May 1, while the earworm injury was from 12.6 to 15 percent higher. After May 15 the yields decreased rapidly with the delay in planting and the injury increased.

While the average yield for all varieties during the ten-year period was highest for the May 1 planting, yet the data show that maximum yields were obtained with greater frequency in the April 15 plots. In the case of the number of ears injured, however, the frequency data favor the May 1 plots.

In addition to the data presented in Table I, notes were taken on the date and period of silking, number of eggs deposited on each variety, percent of grain injury and number of overwintering pupae. The results of the study of silking and number of eggs deposited were dis-

TABLE I. A SUMMARY OF THE YIELDS AND EARWORM INJURY OF DIFFERENT VARIETIES OF CORN PLANTED AT DIFFERENT DATES AND THE FREQUENCY WITH WHICH MAXIMUM YIELDS AND MINIMUM INJURY WERE OBTAINED. 1909–1919.

Planted	Total	Yield in pounds Maximum	Yield in pounds Minimum	Yield in pounds Average	Per cent of Injury Maximum	Per cent of Injury Minimum	Per cent of Injury Average	Frequency Maximum Yield	Frequency Minimum Injury
				Kansas Sunflower					
April 15	988	123	17	98.8	96.0	48.5	68.5	5	4
May 1	1023	322	14	102.3	100.0	39.4	65.1	2	5
May 15	968	315	4	96.8	100.0	35.7	77.8	1	1
June 1	859	261	1	85.9	100	44.2	90.0	1	0
June 15	776	240	0	77.6	100	87.4	96.6	1	0
				Hildreth					
April 15	1078	390	8	107.8	100	32.8	70.9	4	4
May 1	1155	319	4	115.5	100	31.5	72.0	2	5
May 15	1120	377	5	112.0	100	50.4	85.0		
June 1	890	241	1	89.0	100	58.5	92.2	2	
June 15	628	157	0	62.8	100	80.0	94.5	2	1
				Boone County White					
April 15	918	264	17	91.8	98	41.9	66.0	5	4
May 1	1086	322	10	108.6	100	31.6	63.4	1	5
May 15	1027	315	7	102.7	94.7	35.7	76.0	2	
June 1	911	258	2	97.1	100	46.0	90.6	1	
June 15	863	236	0	86.3	100	79.0	95.7	1	1
				Commercial White					
April 15	789	323	21	112.7	97	30.3	67.2	3	2
May 1	828	401	12	118.3	100	27.4	64.9	1	4
May 15	800	363	4	114.3	100	32.6	79.9	1	
June 1	711	340	1	101.6	100	44.7	88.5	1	
June 15	689	259	0	98.4	100	83.8	94.4	1	1

cussed in a previous paper[3] in which it was shown that the number of eggs deposited on a variety was correlated with the time and period of silking and this in turn influenced the infestation. From the standpoint of the number of eggs deposited, it was found that Boone County White should be planted between April 15 and May 1; Commercial White about May 1; and Kansas Sunflower and Hildreth between May 1 and May 15.

The determination of the percent of grain injured supports the results already presented in that the May 1 plots had from 2 to 3 percent of the grain destroyed, while from 4 to 6 percent was injured in the April 15 plot, and from 8 to 12 percent in the plantings of May 15 to June 12. Incidentally, it might be mentioned that the May 1 corn was comparatively free of the various molds and fungi which usually accompany earworm injury.

The number of overwintering pupae in a square rod of soil in each planting was determined during several years of the experiment. The results show that the number of pupae increased with the delay in planting. The first three plantings averaged from two to four living pupae per square rod, while the later plots had from eight to twelve.

Summary

An experiment to determine the best time to plant corn to obtain maximum yields and minimum earworm injury was conducted at Manhattan, Kansas, for a period of ten years. Four standard varieties of corn were used and data were taken on all phases which are associated with earworm activities. An analysis of all the data obtained in this study shows that May 1 is the optimum date to plant corn, although the results secured in the various phases of the investigation indicate that this date actually lies somewhere between April 15 and May 1. Experiments are now under way to determine the exact date when each variety of corn should be planted in Kansas to obtain the best yields and the lowest amount of earworm injury.

President A. G. Ruggles: The next paper is by Leonard Haseman and S. W. Bromley.

[3]McColloch, J. W. A Study of the Oviposition of the Corn Earworm with Relation to Certain Phases of the Life Economy and Measures of Control. Journ. Econ. Ent., 13:242–255. 1920.

CONTROLLING CHINCH BUGS IN MISSOURI WITH CALCIUM CYANIDE

By Leonard Haseman and S. W. Bromley

Abstract

The results secured from the use of the new chemical calcium cyanide for destroying chinch bugs at wheat harvest are given. Calcium cyanide did not prove practical when sown broadcast in infested wheat fields or when applied as a line barrier on the surface of the ground. In tests where it was applied in a narrow strip or trap crop between wheat and corn fields, it proved promising. However, best results were secured when the material was distributed in a narrow line in the bottom of a deep narrow furrow such as made with a plow. The furrow should have practically a vertical wall next to the crop to be protected and a line of the chemical placed at the foot of the vertical wall. One pound of calcium cyanide flakes to each sixty linear feet of furrow applied in the afternoon when heavy migration of bugs began, proved effective in destroying the bugs for the rest of the day. This requires about 22 pounds, costing four dollars a day for material used in a quarter of a mile of barrier.

The chinch bug is one of the few serious naturalized insect pests of field crops. A glance at the literature dealing with the chinch bug shows it to have been one of our earliest and most important insect scourges. The early writings of Riley, Walsh, Webster, Forbes and others abound with descriptions of chinch bug epidemics, the life history of the pest and methods of controlling it. In fact, a careful study of these early writings and most of the later articles on this insect leads one to wonder if the earlier workers actually left much for the present day entomologists to find out either as regards life cycle or control.

Who first observed the wintering habits of the pest and recommended winter burning of grass and other rubbish to destroy the hibernating adults? What important new discoveries or recommendations have we made recently on this phase of the subject? Likewise who first found that at wheat harvest, the pest by migrating to corn again exposed itself to flank attacks with barriers? Who first recommended the use of dust barriers, and who the chemical barriers? What new discoveries have we made along the line of barriers in the last thirty years? Some new chemicals have been developed and some improvements made along the line of methods, but when all is said and done we of the younger generation must frankly confess that we have closely followed the worn entomological paths. The senior author can say this frankly and without fear of offending any co-worker in the chinch bug field, where he himself has labored these many years.

These general remarks are meant neither as fault-finding nor as an apology, but rather as a challenge to the younger men. That the

earlier recommendations on chinch bug control have failed to properly control the pest in some localities in recent years is unquestioned. How much of this has been due to lack of cooperation on the part of the farmer, we shall not attempt to estimate. However, it is true that for the past several years this pest has continued to extract its annual toll in the corn belt. Our failure to hold the pest is either due to ineffective remedies or inability to get the farmers interested in applying them thoroly. In either case it seems wise that we attempt to find some new and more effective line of attacks. The psychology of something new against the chinch bug is not to be overlooked, when dealing with chinch bug afflicted farmers. This is especially true if the new recommendation proves both effective and practical.

With these general observations we shall proceed to briefly describe the use of calcium cyanide for the control of chinch bugs in Missouri. Much remains to be found out about this new chemical as an insecticide but we have gone far enough to feel sure that it will play an important part in future chinch bug campaigns.

Calcium Cyanide

Calcium cyanide unlike potassium and sodium cyanide is a comparatively new chemical. It has been used successfully for a few years as a fumigant in the tunnels of rodents. George E. Sanders was the first to take special note of this chemical as an insecticide and he interested others in testing it. Flint made some preliminary tests with the material on chinch bugs in the fall of 1922. During the summer of 1923 the material was used on chinch bugs in Indiana, Illinois, Missouri, Kansas and Oklahoma in an experimental way and also quite extensively in practical field control in Missouri.

Calcium cyanide reacts with atmospheric water vapor, giving off hydrocyanic acid gas that makes this new chemical valuable as a barrier to the migrating chinch bugs.

Tests on Rate of Emission of Gas

At the outset laboratory and field tests were made to determine the rate and duration of the emission of gas. The influence of moisture, temperature and wind were studied. In these preliminary experiments only adult bugs were available for use at Columbia, Missouri. In order to make field tests using the immature bugs, the junior author was sent to Oklahoma for several days work. The purpose of these tests was to arrive at some definite conclusions regarding dosage and method of laying down the chemical as a barrier before wheat harvest and chinch bug migration began.

Tests were made with the material dusted or sown broadcast in wheat, scattered along narrow strips, as a line on the surface of the ground, in furrows of different types and covered with dry dust. The powder, granules and flakes were all used.

Broadcasting in Wheat

Some of our first work dealt with the use of the material sown broadcast in the wheat. Varying doses of the granules and powder up to 60 pounds to the acre were used. Repeated tests with this later dosage of granules, even with a five to ten mile breeze gave an almost complete kill not only of the chinch bugs but also ground beetles, Colorado potato beetles, grasshoppers, wasps, bees, lady beetles, plant lice and other insects which became enveloped with the gas. The heavier doses also caused some leaf burning. The use of the material for broadcasting in wheat fields was abandoned as impractical, the acreage, dosage and difficulty of application prohibited its use.

Calcium Cyanide as a Barrier

From the beginning the use of the material as a barrier seemed the most logical. In the preliminary tests it was used in a narrow strip two or three feet wide, in a narrow line on the surface of the ground and in a ditch. Dosages were used varying from one half pound to four pounds to each 60 feet. The heavier dosages maintained a killing barrier much longer than the lighter ones. It was soon found that for a line barrier the coarser flakes gave off gas more slowly and therefore lasted longer than either the granules or the powder. Later barrier work, therefore, dealt mostly with the flakes and our final conclusions on dosage refer to flakes rather than granules or the powder.

Narrow Strip Barrier with Trap Crop

The use of the material in a narrow strip was not given a thoro test due to the fact that trap crops had not been planted for the purpose. Several opportunities for testing the material in strips of sorghum were offered and gave satisfactory results with as small an amount as 30 pounds to the acre. After making a few tests with varying dosages it was abandoned for the line barrier. However, with trap crops of cane or sudan grass planted about a month before harvest, we believe from our observations that it will prove practical.

Line Barriers

Our line barriers were made first, on the surface of the ground, second in trenches of varying depths and forms and third, tho only in a few tests, covered slightly with dry dust. It is desirable to keep a

death line of gas as long as possible and with the least effort and use of material. Hydrocyanic acid gas is of about the same weight as air and when there is no breeze to scatter it, it will hover over the line of flakes whether on the surface of the ground or in a furrow. However, at wheat harvest there is usually a great deal of wind so it is necessary that this be taken into account and guarded against as well as possible.

Line Barriers Applied on Surface of Ground

In our preliminary tests with the surface barriers we used from one half pound to four pounds of granular cyanide to sixty linear feet of barrier. The smaller dosage applied when there was a six-mile wind, killed adults bugs which attempted to cross, for only one hour. The heaviest dosage, applied under the same conditions, remained effective for from three to five hours and killed some bugs five feet from the line due to drifting of gas. These also burned the lower blades of wheat. A dosage of one pound to sixty linear feet of barrier on the surface of the ground remained effective for only about two hours on the average. The drifting of the gas from a surface barrier is too great for most effective results.

Line Barriers Applied in Furrows

Furrows may be made of various shapes and forms and our results show that a narrow, deep furrow gives far better results than do those of other types.

In our first tests we used a hoe and a hand plow to make a shallow ditch from one to three inches deep. This showed a decided improvement over the line on the surface of the ground due mostly to the fact that it retarded the progress of the bugs and kept them longer in the gas area. A very shallow ditch does not help materially in checking the drifting of the gas, but it will keep the bugs busy longer climbing out of the gas area.

A deep furrow made with a plow and rounded out with a post, was then used. This provides a definite container for the gas and where there is no breeze it should be expected to work well. However, in our tests it was found that a broad rounded-out furrow of this type allowed the gas to spread out in the furrow, and it permitted the wind to blow it out readily. The broad furrow in our tests gave no better results than a narrow shallow furrow made by hand. However, it does provide for the possibility of combining a mechanical barrier with the gas barrier.

To chinch bug workers it is a well known fact, that normally at harvest the bugs move mostly during a few hours of the day and only

light scattering movement occurs during the rest of the day. When the gas and mechanical barriers are combined the log, as in the ditch-log barrier, can be kept moving thruout the morning when but few bugs are moving, and then the gas barrier laid down in the afternoon when heavy movement starts.

However, Missouri farmers prefer either to fight all the time with the ditch-log or to use the gas alone. Only a few reported using the combined barriers.

In our tests the broad, rounded furrow with one pound of calcium cyanide to sixty feet remained effective for only two or three hours and did not prove entirely effective thruout the afternoon migration.

The type of furrow used most in Missouri was a plowed furrow with the dirt thrown toward the wheat stubble and the side next to the corn as nearly as possible a vertical wall. This is the type of furrow most farmers make and we have found it to be the most effective. This is probably due to the fact that it provides the best protection against the drifting of the gas and the concentrating of gas at the foot of the vertical wall. The vertical wall is also an effective barrier up which the bugs, already weakened by the gas, are unable to climb. In such a furrow one pound of calcium cyanide flakes to each sixty feet applied in the early afternoon proved effective in preventing bugs crossing for the rest of the day. This is the dosage and type of furrow and method of application which gave us best results this summer. Likewise, this is the type of barrier used by most of the farmers in the state. Our tests were made in different counties in the northern part of the state thruout the migration period. The migration was later than normal and more drawn out than usual which made the use of any type of barrier more difficult than under normal conditions. We believe, therefore, that in a normal season with a heavy active migration of bugs, the gas barrier would have worked more rapidly, cleaned up the bugs in fewer days and thus proven more effective and cheaper. Still our results last summer were highly satisfactory and the farmers using the material were pleased with their results as the following summary of their reports will show.

Sixty-five questionnaires were sent out to Missouri farmers, who used calcium cyanide for chinch bug control, and thirty-three replied. Of these, twenty used the material in a furrow and all reported success even tho four used less than one pound to sixty feet of barrier a day. Thirteen used other methods and all but one of these reported satisfactory results. Of those following directions only one considered the

material too expensive. This is further attested to by the fact that the Missouri Farmers Association, an independent organization of some 70,000 Missouri farmers have just recently contracted for a minimum of twenty tons for their 1924 chinch bug campaign.

Summary

(1) Calcium cyanide flakes used in a properly prepared furrow at the rate of one pound to sixty linear feet once a day proved an effective chinch bug barrier in Missouri. The material in such a barrier cost about four dollars a day for a fourth of a mile of barrier.

(2) For best results it should be applied in the early afternoon or when the daily migration begins.

(3) A narrow, deep furrow with a vertical wall next to the crop to be protected proved to be the best type of furrow in which to apply the calcium cyanide flakes.

(4) Other type of furrows or methods of applying the chemical did not prove so effective.

(5) Temperature, moisture and wind are factors influencing the success of such a barrier.

Question: What is the cost per mile of treating such a furrow?

Mr. Leonard Haseman: About $4 per day for a quarter mile. It depends upon the rapidity with which the gas cleans up the infestation. That really determines the total cost.

Mr. J. J. Davis: I want to make a brief statement regarding the use of calcium cyanide in controlling chinch bugs. The results obtained in Indiana are not sufficient to permit definite recommendations and I wish at this time simply to bring out the fact that we must look to cheaper calcium cyanide or more efficient methods of application to make its use practical under Indiana conditions. Mr. Haseman recommends it at the rate of one pound to 60 linear feet, which, at 18 cents a pound would cost $3.96 per quarter mile per day or $55.44 for material to treat a quarter mile furrow for 14 days, the minimum period of chinch bug migration. By using the creosote barriers, which Mr. Flint has found to be very effective in Illinois, and which we have also found to be effective in Indiana, the cost for material per quarter mile for the entire period of chinch bug migration is $6.00 or $7.00. The difference in cost is too great to consider calcium cyanide as a practical chinch bug control at the present time.

Mr. J. A. Hyslop: Mr. Haseman's statement in regard to broadcast treatment with calcium cyanide destroying the bugs, brought to my mind the statement of Mr. Turner, that the broadcasting treatment now being used in Georgia, for the weevil, made so extreme a change in the biological complex in the cotton fields, that the cotton aphis was very much more destructive in the fields treated than those not treated. I believe in these new, very extensive treatments that the Entomologists are using, that we will do well to consider the changes in the complex in relation to other insects than with which we are working.

The final business of the Association was then transacted and the meeting adjourned.

NEW DEVELOPMENTS IN ALFALFA WEEVIL ACTIVITY AND CONTROL

By Claude Wakeland, *Entomologist, Idaho Agricultural Experiment Station*

Investigational work was undertaken by the Idaho Agricultural Experiment Station this year to determine why spraying for the control of alfalfa weevil (*Phytonomus posticus* Gyll.) in southwestern Idaho had not proven so successful as elsewhere. The situation is of more than local interest because it shows the error of assuming that problems that have been successfully solved by research workers can be turned over to extension workers and forgotten.

Spraying for the control of this insect has been recommended generally as a practice proven by experiments conducted by the U. S. Bureau of Entomology (1) (3) and by the Colorado Experiment Station (2). It was found that one spray application reduced the injury to such an extent that little loss was sustained on the first crop and the second crop started growth immediately after the cutting of the first crop. This spray is applied at a time designated by Reeves and his co-workers as the "turning point of injury" (Fig. 8). This turning point is governed by the relative development of the weevil and its host plant and occurs close to the date when the greatest number of larvae are emerging, which usually is from one to three weeks before the date of cutting of the first crop. In Utah and Colorado the majority of the larvae usually emerge from the eggs at a rather definite time, which may be designated as the "height of the hatching season." Under conditions there, height of hatching season and turning point of injury are nearly analagous terms when considered in relation to the timing of spray applications.

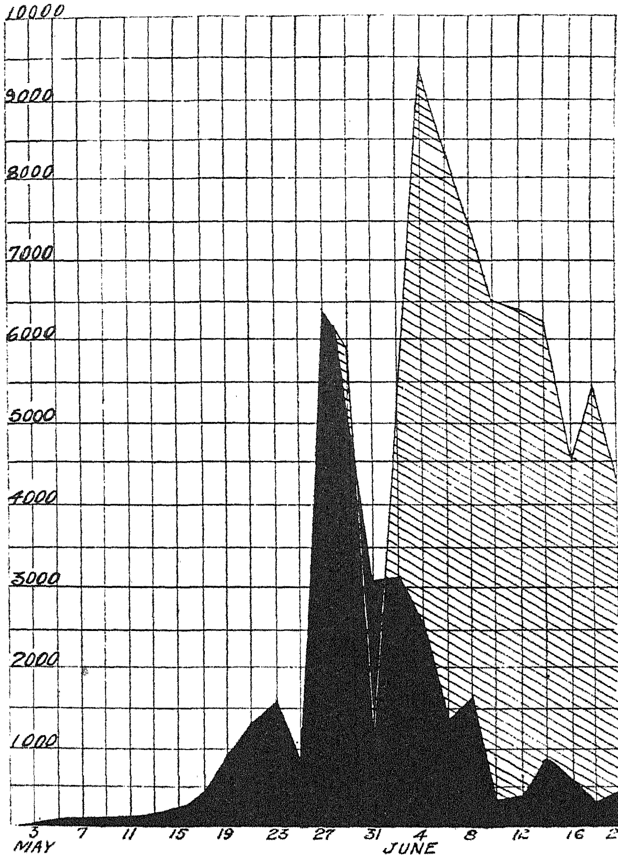

Fig. 8.—One spray application, western Colorado. Horizontal lines represent number of larvae collected in 100 sweeps of the net. Black area represents sprayed portion of field and cross-hatched area unsprayed portion. Sprayed May 27. Plots cut June 20. (Adapted from Eleventh Annual Report, Colo. State Entomologist).

Extension work conducted by the University of Idaho was for three years based on experimental results cited above. The spray was applied at the time of the turning point of injury which, roughly defined, was when larvae became so numerous in the alfalfa tips as to check the growth of the plants. The general plan of work was to conduct spray demonstrations starting in communities of earliest growth and proceeding, as the season advanced, to those of later development and higher elevations. A demonstration machine equipped for alfalfa

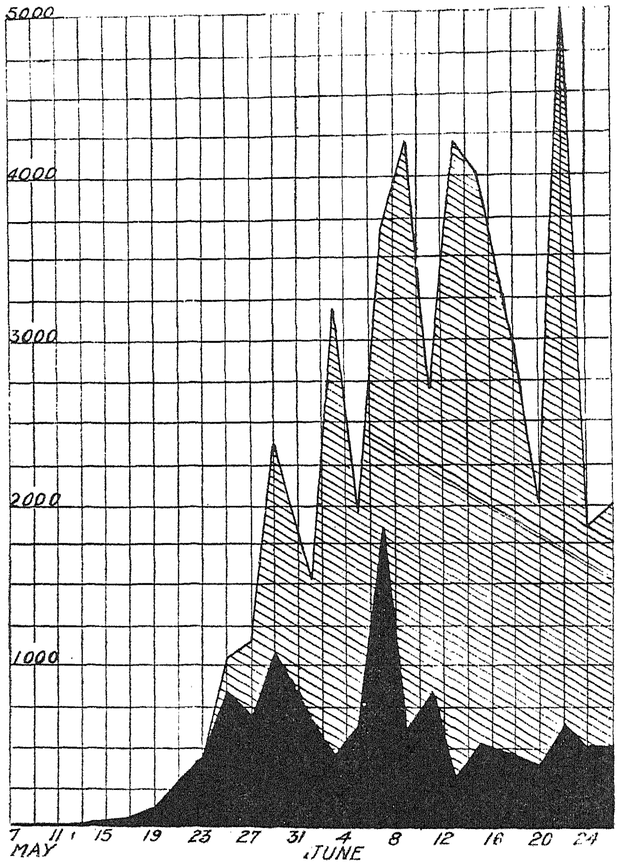

Fig. 9.—One-spray application, southwestern Idaho. Sprayed June 7, 1923. Plots cut June 27. Note the large numbers of early-season larvae on sprayed plot which were sufficient to cause serious injury.

spraying was transported on an auto truck. The difference in development of the weevil in different localities of the state is very favorable to a long demonstration season, and an effort was made to conduct as many demonstrations as possible during a season. Conditions that favored a long demonstration season were the ones also that made it impossible to observe results closely, and the entomologist was rarely enabled to return to a sprayed field in time to make observations of results obtained. Reports received from county agricultural agents and from farmers varied widely and were extremely confusing. Reports were that results in eastern Idaho were satisfactory. In the south-

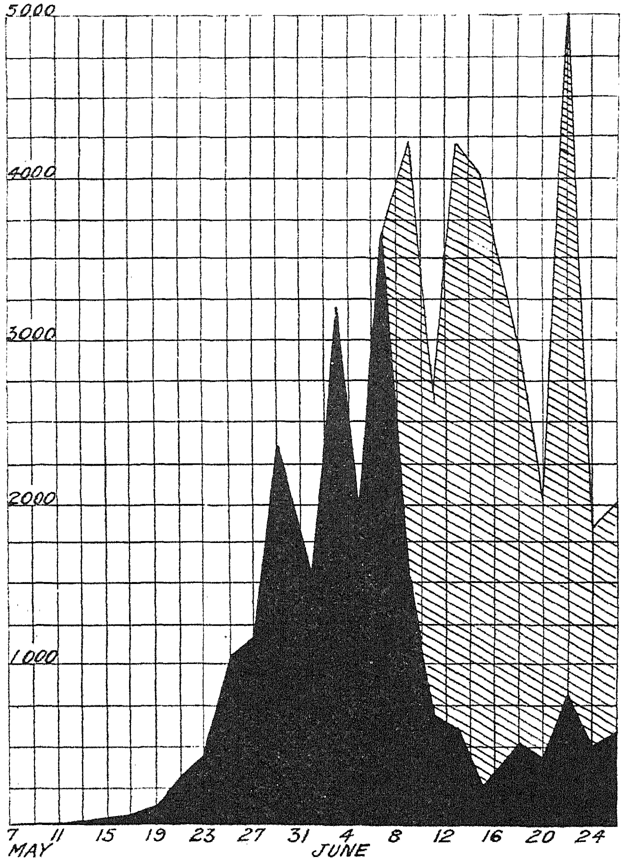

Fig. 10.—Two-spray application, southwestern Idaho. Sprayed May 24 and June 7. Plots cut June 27, 1923. Amount of injury on sprayed plot was slight compared with check. Note decrease of larvae on sprayed plot following each application and comparatively small proportion of early-season larvae.

western part of the state, however, the first reports following a demonstration were favorable, only to be followed by others that spraying had not proven successful. In several communities in that part of the state spraying had been tried by individuals, the knowledge that spraying by them and by the University had not proven successful had become common, and it is little wonder that others were loath to try it.

For experimental work in southwestern Idaho, which has probably proven to be the worst injured portion of the United States, a large field of alfalfa was selected in which growth and cultural conditions were as

nearly uniform as it was possible to obtain, and measured; one-acre plots were staked out. On each plot conditions of growth were noted throughout the period of development of all three crops for the season, and during the period of growth of the first crop larval counts were made each alternate day after the alfalfa became tall enough to sweep with a net. The fact that results in former years had appeared to be good for a time after spraying indicated that possibly an additional spray application was needed. This possibliity was supported by the fact that field examinations during the two previous years had disclosed large number of freshly deposited eggs in the stems after the spray had been applied. Among other experiments it was therefore determined to try applications of one and two sprays and to check the results of each against an untreated plot. For the purpose of this discussion no mention will be made of plots other than numbers 1, 3, 5 and 6.

Plat No. 1 was sprayed May 24th with calcium arsenate at the rate of two pounds per acre. A pressure of 225–250 pounds was maintained. On that date the alfalfa was a little less than knee high, and blossom buds were just plainly visible in the tips without careful inspection. Bud clusters were not separating and no color was showing in any of the buds. Larval injury was general over the entire plot, though not severe, and there was no noticeable checking of growth. Most of the larvae were large in size, some nearly full grown and rarely a cocoon was observed. It was a striking fact that injury that necessitated a spray was caused by early-hatched larvae, and that those representing the main part of the brood had not yet appeared, even in an early stage. (Fig. 9.) Observations on the check plot throughout the season showed that without spray little growth was made after the date mentioned above, altho the height of larval emergence did not come until 21 days later, so that a field that had been sprayed just preceeding this height would have been so severely injured as to not make recovery.

After spraying, the alfalfa on plot No. 1 grew almost normally for a time, and rapidly recovered from the previous injury. On June 6th it was noted, however, that the green growth had been made since spray was applied was being attacked and a second spray application was made on June 7th (Fig. 10). At that time the alfalfa was a little more than knee high, blossom buds were broadly separated and an occasional one showed the color of an opening blossom. The majority of the larvae at that time were small, were but recently emerged and represented a portion of the main brood. At cutting time this plot was about one-half in blossom; foliage was a green, healthy color and

showed very little injury. The second crop started immediately, altho a little ragged, and made a steady, rapid growth.

Plot No. 3 was sprayed but once, the date being June 7th. At that time the general appearance of the field was brownish and the foliage was severely injured. After spraying, it recovered gradually until at cutting time the predominant color of the tips was green, and there was a ragged sprinkling of bloom over the entire plot. The second crop was slow and irregular in starting. A striking contrast between plots one and three was in the greater number of pupae on the latter due to the transformation of early-emerged larvae before the application of poison.

Plot No. 5 was cut early, June 7th. A notion exists among some farmers that the alfalfa weevil can be controlled by cutting the first crop early before it is injured. On the date mentioned very little injury had occurred on this plot, and it was cut in accordance with this notion. Even tho the first crop was cut three weeks earlier than on Plot No. 1, the second crop was two weeks later starting, thus five weeks elapsed after the cutting of the first crop before second crop growth started. An important point in relation to the maintenance of an alfalfa stand is here involved. Without control a field heavily infested with alfalfa weevil cannot make second crop growth until such a time as a majority of the larvae have entered the pupal stage and ceased feeding. During this time foreign grasses and weeds have an opportunity to make a quick, unrestricted growth. This condition is usually aggravated by the farmer who thinks to stimulate his alfalfa to a rapid recovery by the free use of irrigation water. The infested alfalfa cannot respond and the grasses and weeds are given an almost ideal condition for establishment and growth. Plot No. 5 was almost entirely green with blue grass (*Poa pratensis*), water grass (*Echinochloa crus galli*), squirrel tail (*Hordeum jubatum*), and *Bromus tectorum* within a few days after cutting, and throughout the growth of the second crop these grasses were so tall as to hide almost completely the alfalfa. No attempt was made to weigh the second crop hay on this plot since there was no means of separating the alfalfa and weeds. After removal of third crop hay this plot showed a heavy stand of grass while the alfalfa stand in an adjoining sprayed plot was in a very good state of preservation. Other investigators have cited the undesirability of early cutting from a physiological standpoint.

Plot No. 6 was untreated and allowed to stand as a check until June 26th when it and all sprayed plots were cut. At that time there

were no blossoms on this plot, and the foliage was so severely eaten as to render the hay almost valueless. Growth was not resumed until three weeks later than on the sprayed field adjoining. Relative stages of development were maintained on all plots throughout the period of growth of the second crop which was cut August 15th.

HAY WEIGHTS

Plot No.	First Crop	Second Crop	Total
1	5957 lbs.	5313 lbs.	11270
5	4761 lbs.		
6	4799 lbs.	4135 lbs.	8934

All the first and second cutting hay on each plot was weighed with the exception of second crop hay on Plot No. 5 as noted above. Third crop hay was not weighed because of weather conditions unfavorable to obtaining accurate data.

COST OF TWO SPRAY APPLICATIONS PER YEAR AND SAVING RESULTING

It has been proven by practical field work that under average field conditions a traction spray machine will care for 200 acres of alfalfa per year, and that with average care a machine should operate satisfactorily for at least five years. On this basis the following calculations are made:

Cost of Spray machine complete with spray bar and filling pump..........	$300.00
Calcium arsenate for 1000 acres, 4 lbs., per acre per year for 5 years, 4000 lbs. @ 20 c..........	800.00
Repairs for machine, estimated at $20.00 per year..........	100.00
Labor, man and team, 70 days, 14 days per year for 5 years, @ $6.00 per day.	420.00
Total cost of spraying 1000 acres twice, 200 acres per year for 5 years.....	$1620.00
Cost of spraying one acre twice, or cost per year..........	$ 1.62

A fair valuation to the farmer for alfalfa hay in Idaho over a period of years is $8.00 per ton. From weight tabulations above it will be noted that the gain in hay per acre as a result of spraying was 2336 pounds. From these figures the net saving is derived:

Sale value 2336 pounds hay @ $8.00 per ton, or gross saving per acre..........	$9.34
Cost of spraying, per acre..........	1.62
Net saving from spraying, per acre..........	$7.72

The loss from weevil is often much greater than occurred this season on the experimental check plot, and saving from spraying is correspond-

ingly greater. Judging from chemical analyses and feeding tests that have been made in connection with previous experiments, the amount of arsenic contained on hay that has been sprayed twice at the rate of two pounds calcium arsenate per acre per application is so small that such hay may be fed to live stock with safety.

Summary

Contrasting conditions in southwestern Idaho with those in the eastern part of the state and in the weevil-infested portions of Colorado and Utah, it has been ascertained that instead of a rapid rise in the numbers of larvae following a somewhat definite "peak" in egg hatching, there was in 1923 a prolonged period of hatching and no definite peak. The "turning point of injury" occurred some fourteen days before the heavy emergence of larvae began to take place. Larvae were present in almost equal numbers for a period of three weeks. The highest point of larval population did not occur until 28 days after the "turning point of injury." Under such conditions it has been determined that two sprays applied to the first crop of alfalfa are needed to afford protection from the alfalfa weevil. There are portions of the state where one spray is sufficient and there may be seasons where a second application will not be needed in southwestern Idaho, but the farmer must be prepared to use it if necessary. With the advance of the fanlfa weevil to still lower and warmer regions other adaptations of caotrol may be required.

References

(1). U. S. D. A. Farmer's Bulletin 741.
(2). Eleventh Annual Report Colorado State Entomologist.
(3). U. S. D. A. Farmer's Bulletin 1185.

OBSERVATIONS ON AN OUTBREAK OF *UTETHEISA BELLA* L.

By M. T. Smulyan and R. T. Webber, *U. S. Bureau of Entomology, Melrose Highlands, Mass.*

The destructiveness of certain species of insects when transplanted from their native habitats to completely new habitats and the destructive activities in their native habitats of certain other species because of the modification of their environments (as through the introduction of new plants) is well known. The first category is well exemplified by such insects as the Gipsy Moth (*Porthetria dispar* L.) and the Japanese Beetle (*Popillia japonica* Newm.), the second by the Chinch-bug

(*Blissus leucopterus* Say) and the Colorado Potato-beetle (*Leptinotarsa decemlineata* Say). The degree and extent of the damage that certain native insects may inflict upon native and economically unimportant plants, however, is not so well known to entomologists, and some observations along that line, dealing with the apparent extinction of a local plant species and the relation of this to the behavior of the depredating insect in another respect is, therefore, worthy of record. The observations were made in Somerset County, New Jersey, where one or the other of the writers was engaged, during the summers of 1921, 1922 and 1923, upon insect parasite studies for the U. S. Bureau of Entomology.

The species of plant involved is the leguminous annual *Crotalaria sagittalis* L. (commonly known as Rattle-box) which ranges, chiefly along the coast, from eastern Massachusetts and southern Vermont to Florida and Texas, and northward in the Mississippi basin to Indiana and South Dakota (Gray, 1908). In Massachusetts, according to Professor M. L. Fernald of the Gray Herbarium, Harvard University, it is found invariably on sandy beaches of ponds, and in wet seasons may be "drowned out." In New Jersey, however, the stands or stations of the plant—those that were under observation at least—were in dry and open places quite removed from bodies of water and extended, respectively, over approximate areas of 5, 80 and 175 square rods.

The insect concerned was the Arctiid moth *Utetheisa bella* L., which occurs throughout the Atlantic States, in this country, and in parts of Canada, the larvae of which are reported by Packard (Fifth Rept., 1890) and by Smith (N. J. Insects, 1909) as feeding on cherry, elm, Myrica, Lespedeza and Crotalaria. The writers, however, have found the larvae only on *Crotalaria sagittalis*, although some of the other reported food plants were present in the localities.

The caterpillars were first observed July 20, 1922, and by August 19, about one month later, they were very numerous, as were also the moths. Some idea of the large numbers of larvae present may be had from the fact that although large numbers of them were collected between August 19 and 24, thousands were still present on the latter date, and as the Crotalaria was now exhausted, they were engaged in an apparently fruitless search for food. This condition obtained, roughly, in each of the three widely separated localities. In no instance, in the case of the food plant, as far as could be observed, did pod-formation and seed-setting take place. The following summer, that of 1923, no Crotalaria could be found on any of its three former sites. The insect

had thus literally wiped out, for the time being at least, a native and uncultivated plant species in three distinct localities.

The destruction of its food plant resulted, as might be expected, disastrously for the insect itself, and the behavior of the insect thus became interesting from another standpoint, namely, as illustrating the phenomenon of a remarkably sudden appearance and disappearance of large numbers of what appears to be a non-migratory insect. As the feeding of the larvae in 1921 was insufficient to attract attention, their numbers that summer must have been very insignificant. And none were found during the summer of 1923. The appearance, subsidence and complete passing of the insect may thus be said to have been contracted within the narrow limits of a single season.

It was the failure of its food supply that was responsible, as far as could be seen, for the extinction of the insect, as no disease apparently was present—none, certainly, in epidemic proportions—and the percentage of insect parasitism as indicated by the rearing of large numbers of the insect was very small.

THE EFFECTIVENESS OF CALCIUM CYANIDE IN THE EXTERMINATION OF THE BLACK TAIL PRAIRIE DOG, *CYNOMYS LUDOVICIANUS* (ORD.)

By Otis Wade, *University of Missouri*

Abstract

The efficiency of calcium cyanide as a control for prairie dogs was tested in 1922 and 1923 in Kansas. The flake form of the chemical was used in dosages of ¾, 1, 1½, and 2 ounces. The material was placed in each burrow entrance from 1 to 2 feet below the rim.

In three "dog towns" doses of 1, 1½, and 2 ounces were used and all entrances to dens closed. Total kills resulted in each instance. Eight infested areas were treated with ¾, 1, and 1½ ounce doses and all burrow entrances left open. In the two tests with 1½ ounce doses total kills were obtained. Complete extermination resulted in one test with 1 ounce doses. In the remaining five tests where doses of ¾ to 1 ounce were used, the effectiveness varied from 90 to 99 per cent.

The killing power of the chemical in open burrows in an important factor, since the closing of burrows involves considerable time and labor.

Preliminary tests by Professor F. L. Hisaw, Kansas State Agricultural College, indicate that calcium cyanide might be effectively used in the eradication of the pocket gopher, *Geomys bursarius* (Shaw). Doses of 1 and 2 ounces were used. The dose was placed in the main run through an opening made with a trowel. After dosing the holes were closed. Effectiveness varied from 88 to 94 per cent.

The use of calcium cyanide for the destruction of rodents was noted in a report by Professor George E .Sanders of Nova Scotia in 1921. In

his experiments the material was used with success in the control of a species of ground squirrel commonly referred to in that region as a "gopher."

Since calcium cyanide is receiving considerable publicity and is being strongly recommended by some as an efficient control for various noxious rodents, it seems desirable to report the results obtained with this material in tests made on the prairie dog in Kansas. These tests for the control of prairie dogs were made by the writer in May and August 1922 and April 1923.

The flake form of calcium cyanide was used throughout these experiments. The doses were placed down in the burrow entrances from one to two feet from the rim.

Except in three tests, all entrances to the burrows were left open after the calcium cyanide had been administered. This was done because it was thought if the material did not prove effective without closing all entrances, which is a slow laborious process, it would not be superior to methods already in use and it was the labor and attendant cost we wished to eliminate if possible.

The following data give the results of the first experiment:

Date	Area	Dosage	Entrances	Results
May 4, 1922	40 burrows	2 ounces	Closed	Total kill
May 5, 1922	58 "	1½ "	"	" "
May 5, 1922	157 "	1 "	"	" "
May 5, 1922	107 "	1½ "	Open	" "

Several inspections of the treated areas were made in May and June and a final inspection July 20. Not a living prairie dog could be discovered. A number of dead burrowing owls were noted in the entrances of open dens.

The second experiment was conducted August 3 with the following results.

Date	Area	Dosage	Entrances	Results
Aug. 3, 1922	88 Burrows	¾ to 1 ounce	Open	About 98% kill
Aug. 3, 1922	64 "	1½ ounce	"	Total kill

August 4 in the area treated with the smaller dose, three live dogs were seen and fresh work around the entrances of two dens was observed. The supply of calcium cyanide being exhausted these two live burrows were treated with heavy doses of carbon bisulfide to insure the death of the inmates. In the second town where more than one hundred prairie dogs were seen the previous day, there was no sign of life and the town appeared deserted. Eight dead burrowing owls were found

in open entrances, three being taken from one burrow. They had evidently gone in the evening after the treatment, which was about 5:00 P. M. and were overcome by the gas, indicating that the effectiveness of the gas is maintained for several hours after the flakes are placed in the burrow entrances.

August 29 the two dog towns were again visited and no live prairie dogs were seen and no signs of fresh work observed about any of the dens. The dogs were completely exterminated.

A survey of the results obtained in 1922 showed satisfactory kills, where entrances to dens were left open, with dosages of 1 to 1½ ounces per burrow. In the two tests made, May 5 and August 3 with 1½ ounces of calcium cyanide to the burrow, total kills were obtained and the other tests made August 3 with ¾ to 1 ounce to the dose was very promising with a kill approaching totality. In view of these results it was decided to continue the work in 1923 with a series of tests using a straight dosage of 1 ounce per burrow, in order to learn if this apparently minimum dose would be entirely effective.

Date	Area	Dosage	Entrance
April 10, 1923	107 burrows	1 ounce	Open
April 10, 1923	250–300 burrows	1 ounce	Open

On April 14 one live dog and fresh signs around five or six dens were noted in the smaller town; in the second town no dogs were observed but there was some sign of their activities, and the owner of the farm said he had seen two dogs the day before. The kill in this experiment was considered to be about 99%.

Another experiment was made as follows:

Date	Area	Dosage	Entrance
April 12, 1923	48 burrows	1 ounce	Open
April 12, 1923	253 "	1 "	"
April 12, 1923	271 "	1 "	"

At the time these towns were treated many of the females were suckling young but as yet the young apparently were too small to leave their nests since none were seen above ground. On May 19 all three dog towns were checked. In the first town no dogs or signs could be seen which indicated a total kill; in the second town three or four old dogs were in evidence and a number of young; in the third town a number of old dogs were seen with a fair sized population of emaciated looking young crawling about in search of food. It was concluded that, at the time the burrows were treated, some of the young must have been about ready to leave their nests but did not, until forced by starva-

tion to do so, when the gas was no longer effective. The percentage of kill was estimated at 90% to 100% in these three towns.

Preliminary tests by Professor F. L. Hisaw, Kansas State Agricultural Experiment Station, indicate that calcium cyanide might be effectively used in the eradication of the pocket gopher. Doses of one and two ounces were used. The dose was placed in the main run through an opening made with a trowel. These holes were always closed after the dosage was administered. In these tests only isolated runs were used and only one dose was put in a run.

Calcium Cyanide dust was tried out in a few holes but proved not to have any advantage over the flakes. One hundred holes were given two ounce doses. In ninety-four of these successful kills were made, or about 94% effective. In 187 holes a one ounce dose was used. Of these, 21 holes were later found to be plugged indicating that the gopher was not killed. In the remaining 166 the treatment was successful, giving a killing percentage of about 88%. Professor Hisaw feels that the holes plugged were for the most part done before gas could be generated from the flakes. He found that his best results were obtained in the spring when the soil was moist, while his poorest results were in the fall when the ground was dry. From this he concludes that the gas generation depends on moisture in the soil. He was able to detect the gas in the run 15 feet from the opening but no quantitative tests were made.

These tests in the destruction of pocket gophers are preliminary and further work is necessary before safe conclusions can be made as to effectiveness under various conditions and the proper dosages to use.

Conclusions

Calcium cyanide when used at the rate of 1 ounce to each burrow was 90% effective or better. When used at the rate of 1½-2 ounces total kills were obtained.

The burrows need not be closed, thus making an appreciable saving in time and labor.

The moisture in the air liberates hydrocyanic acid gas which remains in the burrow for several hours diffusing in all directions. The prairie dogs are killed in their attempt to come through this curtain of toxic gas, very small amounts proving fatal.

Temperature apparently is not a limiting factor in the use of calcium cyanide providing the inmates of the burrows are active.

Preliminary experiments indicate that calcium cyanide may also be used for the destruction of pocket gophers.

Scientific Notes

Blister Beetle—Serious Pests in Northern Arizona. Serious infestations of blister beetles during the past two years have made potato raising an uncertain problem in Chino Valley and on farms near Prescott. This being a comparatively new farming region and a tract of ground only recently opened up, it is evident that the beetles are migrating from the native vegetation. As two of the beetles have not heretofor been reported from Arizona, the following notations are of interest.

Macrobasis longicollis Lec.—On July 18, 1922 in Chino Valley these insects were found traveling in swarms and completely defoliating small potato fields. There were considerable areas where even the stems were cut to within four inches of the ground. By August 10, 1922 the swarms had scattered and the beetles could only be seen here and there on fields that had escaped the earlier infestation. In the summer of 1923 they again appeared in numbers.

Epicauta corvina Lec.—Approximately a month after the visitation of *Macrobasis longicollis*, this species put in its appearance in the same locality. These did not travel in swarms but could be seen running in all directions over the fields, along the ditch banks and across roads. They did not concentrate on the potato fields alone since their native food, the puncture plant (*Tribulus terrestris*), was growing abundantly on the waste ground and along the road sides. The insects were feeding on the potato plants and the weeds in about equal numbers.

Epicauta pardola Lec.—In June 1922 these blister beetles were found in great swarms feeding on alfalfa and potatoes in Skull Valley. The beetles were so numerous that from a little distance the alfalfa appeared blue as though it were in full blossom. In some instances as many as fifty beetles could be found on a single plant. They feed on the most tender leaves and buds, necessitating an early cutting of the crop.

In general the spraying with arsenate of lead has been done after the insects began their attack and this is generally too late in the case of *Macrobasis longicollis*, as the insects are capable of defoliating large areas in a few hours. The spray applied at the first appearance of the beetles killed large numbers, but not before evident damage had been done. In the case of *Epicauta corvina* it was used with a greater degree of success.

HAROLD R. BRISLEY, *Plant Pathologist, United Verde Extension Mining Co., Clemenceau, Arizona*

Toxicity of Sodium Fluoride to Man. The growing use in the home of sodium fluoride against roaches and as a repellent for ants emphasizes the need of definite knowledge of its toxicological principles. Sollman's "Pharmacology" states that "Fluorides have a very strong local irritant action. Their systemic action resembles that of oxalic acid and is probably produced in the same manner by the formation of insoluble calcium salts." In a recent paper (Jour. of Pharmacology and Experimental Theropeutics, vol. 17 (1921), p. 197) the same author states that "Small doses of soluble fluorin preparations, even to one miligram per kilogram (0.06 of a gram for a 160-pound man) of weight are toxic and should be absent from the food of man and animals." The symptoms of poisoning from the fluoride iron are muscular weakness, difficulty of breathing, low blood pressure and inflammation of the entire alimentary canal."

A recent article in the Journal of the American Medical Association (Pittsburg), vol. 64, p. 1985, states that, "the toxic effects of the fluoride ion is similar to the oxalate ion. Intravenous injections of a dog in dosages ranging from 0.05 to 0.1 of sodium fluoride per kilogram of weight were fatal. The Massachusetts State Board of Health Monthly Bulletin (vol. 6, pp. 341–343) reports one death and several cases of poisoning from the mistaken use of insect powders, containing sodium fluoride. Several samples were anaylzed and found to contain from 16 to 62 per cent of sodium fluoride, but bore no poison label. The Journal Pharm. Chem. (vol. 21 (1920), pp. 5–8) gives a record of the poisoning of seven persons who had partaken of pastry, in the preparation of which sodium fluoride was by mistake used instead of bicarbonate of soda. The amount taken by each individual ranged from 0.228 to 0.456 gm. Nausea and vomiting followed, the attack lasting from three to twelve hours, followed by 36 hours of weakness. The giving of milk aided in recovery. Calcium lactate or other soluble calcium salts may be given as an antidote, —dosage 1 gm. (15 grains) or a few spoonsful of lime water may be substituted.

E. R. DeOng, *University of California*

Acarapis woodi **in Czecho-slovakia.** Since the discovery of *Acarapis woodi* by Rennie in 1920 in connection with the Isle of Wight disease, observations have been made in several countries on this species. The species is given by Rennie and his associates as the cause of the above mentioned disease of adult honeybees, and this opinion is generally accepted, this being the first definitely recorded case of a mite being pathogenic on an insect. In Switzerland, Morgenthaler found this species, or one which can not be distinguished from it, on the outside of honeybees that had died during the winter, no evidence of disease having been noted previously. Since that time, however, a number of instances of disease of adult bees have been located in French Switzerland, in which cases the tracheae of the diseased bees were filled with this species of mite. The pertinent literature on this subject is recorded in U. S. Dept. of Agric. Circulars 218 and 287.

Last May a letter was received from Rev. Ivan F. Kitzberger, editor of a leading bee-journal in Prague, stating that *Acarapis woodi* had been found in Czecho-slovakia (see pp. 21–22, Circ. 287), the identification having been made by Mr. Ctibor Blattný, a specialist on mites located at the Zoological Institute, Prague. Several other species of mites, both larvae and adults, were identified from material collected on combs which had been removed from the hives for some time. The Isle of Wight disease seems to be unknown in Czecho-slovakia.

An inquiry to Rev. Mr. Kitzberger for more information brings some rather important and most interesting reports from him and also directly from Mr. Blattný-Kitzberger reports in a letter dated December 28, 1923, that *Acarapis woodi* was found living free on empty combs (containing pollen) which had not been in a colony of bees for at least a year. These had been stored in a moist cellar but for three or four months had been placed in a warmer, dry room. In a personal interview with Mr. Kitzberger in January 1924, Mr. Willis J. Nolan, of this laboratory, learned that in all ten specimens of Acarapis were thus located. These combs were somewhat infested with the greater wax moth also. In a letter dated October 24, 1923, Mr. Blattný states that in his opinion *Acarapis woodi* is normally a saprophyte, which perhaps because of some change in environmental conditions has in some cases become parasitic.

With these two letters there came a microscopic slide on which was mounted the

mite which Blattný had identified as Acarapis. This has been examined by Dr. H. E. Ewing, who states that it is beyond question an adult female of *Acarapis woodi*.

It is not the purpose of this note to make any interpretation of these findings but merely to bring them to the attention of interested persons in this country, thus paying a slight tribute to the scientific work now being undertaken along beekeeping lines in this new European republic. One can not, however, avoid mention of the fact that there is still much to learn regarding the interrelationship of Acarapis and the bee and that the cause of the Isle of Wight disease is still a problem worthy of attention. This does not in any degree indicate a reduction of the loss from this disease, nor justify any relaxation in preventing its introduction into America.

E. F. PHILLIPS, *Bureau of Entomology*

Thrips on Box Elder. About the middle of August, 1922, in passing through Box Elder County, Utah, I observed a very conspicuous discoloration of the leaves of Box Elder trees, especially within the limits of Willard. The most seriously affected leaves were generally high in the trees or at the end of long shoots. The discoloration was silvery and many trees were badly affected throughout—even partially defoliated. In Salt Lake County the condition was much less prevalent but quite common, especially near Magna. In 1923 the injury appeared again in Salt Lake County and was also noted near Prescott, Arizona. The causative agent is a small brownish thrips. Specimens sent to Mr. J. D. Hood have been provisionally referred to *Scirtothrips citri*.

WYATT W. JONES

JOURNAL OF ECONOMIC ENTOMOLOGY

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The symposium on estimating the abundance of insects opens up a wide field in relation to entomological statistics and reveals considerable diversity of method. There is little question but that injuries caused by insects are greatly underestimated as a rule and the benefits resulting from judicious control measures are very rarely fully appreciated. There is a marked difference between the percentage loss in the crop and the financial loss resulting from insect operations—market conditions very materially affect the latter. Economic entomology, before it is fully appreciated, must evaluate itself with a reasonable degree of accuracy, therefore the estimating of the abundance of insects and the losses from pest depredations have a greater practical value than appears at first sight. There is a weak link in the chain of circumstances which permits the repeated halving of estimates made by experts and the publication as actual losses of figures one-eighth the size of the original estimates. It would seem from subsequent developments that the experts were nearly right and that there was need of educating those responsible for the reductions. A well developed and comprehensive method of estimating would have gone far toward remedying the condition, and there is no question but that we are progressing in this direction. The problem is really a very complicated one and present methods can not be scrutinized too closely in order to avoid everything of a doubtful or misleading nature in regard to our estimates. They should represent, so far as may be, an accurate picture of conditions and

should be stated in such terms as to be comparable for different sections of the country and over a series of years. It would seem that as a general rule, the proportion of plants, fruits, etc., and the proportionate injury to such would the most reliable standard, supplemented in some, possibly many, cases by statements of the estimated financial losses. The latter are valuable even though they are materially affected by market conditions. There is little need of the economic entomologist magnifying insect losses. One of his chief problems is to present a clear picture of what insect depredations actually mean and through this presentation convince the public of the economic justification of such control measures as may be advocated.

Current Notes

Mr. C. H. Popenoe of the Silver Spring laboratory, Bureau of Entomology, is taking special work at the University of Maryland.

Mr. W. V. Tower, Entomologist of the Federal Experiment Station in Porto Rico, has resigned to accept a position with a Porto Rican tobacco company.

According to *Entomological News*, Mr. Edwin A. Bischoff, a coleopterist of Newark, N. J., died December 23, 1923, in the 58th year of his age.

Professor W. C. O'Kane of the University of New Hampshire spent a couple of days at Iowa State College, Ames, Iowa, during the fore part of January.

Dr. Herbert Osborn lectured before the classes in Entomology at the University of Tennessee during the first week in January. Dr. Osborn was tendered a banquet by students and faculty members during his stay in Knoxville.

Doctor Alexander D. MacGillivray, Professor of Entomology at the University of Illinois, died suddenly of heart failure at his home in Urbana early on the morning of March 24. He leaves a widow and two sons.

Col. Clarence Ousely, formerly Assistant Secretary of Agriculture, has been engaged by the New Orleans Boll Weevil Control Association as Secretary and Manager of Activities.

Mr. K. C. Sullivan, Assistant Professor of Entomology, University of Missouri, will pursue graduate work in the Entomology Department, Cornell University, during the summer term.

Mr. Stefan Keler is now Forest Entomologist of Poland, and his address has recently been changed from 22 Nabielaka, Lwow, to: Bydgoszcz, Panstwowy Instytut Naukowo-Rolniczy, Wydziat Chorob Roslin, Poland.

Mr. Barton C. Ressler, a graduate assistant in Zoology and Entomology at Iowa State College, Ames, Iowa, has accepted a position as Assistant Professor of Zoology at the University of Tennessee.

Mr. T. H. Jones, for many years a collaborator of the Bureau of Entomology, truck crop insect investigations, has been appointed to a position in the gipsy moth investigations of the Bureau.

According to *Science*, Mr. E. Ballard has resigned his post as lecturer in entomology in the University of Bristol on his appointment as entomologist to the Empire Cotton Growing Association in Queensland.

Mr. T. C. Barber, Bureau of Entomology, has returned from a trip into Mexico. He reports finding several new parasites of the sugar-cane moth borer, one of which seems to be very efficient.

According to *Entomological News*, the Honorable N. C. Rothschild, a well-known British entomologist, died October 12, 1923. His splendid collection of Siphonaptera, with an endowment of ten thousand pounds was willed to the British Museum.

According to *Science*, the New York State Agricultural Experiment Station has leased from Vassar College a building which is to be used for special research in entomology and plant pathology in the Hudson River Valley.

Mr. N. E. Winters, in charge of the cooperative boll weevil investigations of this Bureau and the South Carolina Agricultural Experiment Station, at Florence, S. C., has resigned, effective January 31, 1924, to accept a position in Argentina.

Mr. O. C. McBride, Instructor of Entomology, University of Missouri, has resigned to accept a position of Instructor of Entomology in the University of Minnesota where he will devote his time exclusively to research work on insecticides.

Mr. G. P. Walker of the Entomological Branch, Canadian Department of Agriculture, delivered a series of entomological lectures at the short courses held during the latter part of the year at the newly established Agricultural School at Fredericton.

According to *Science*, Mr. Harold Tappin goes in the capacity of Assistant Entomologist with the eighth expedition of the Department of Tropical Research of the New York Zoological Society, which left on February 11 for Georgetown, British Guiana.

Mr. J. R. Parker, Associate Entomologist in the Experiment Station at Montana State College, returned in February from an absence for study at the University of Minnesota, where he has been pursuing work for the degree of Doctor of Philosophy.

Dr. J. D. Tothill and family left Fredericton on February 15 for a vacation in England. While in London, Dr. Tothill will spend several days examining and redescribing the Walker types of North American Tachinidae in the British Museum Collection.

The following entomologists visited Washington on February 8 to attend conferences and hearings: W. C. O'Kane, Durham, N. H.; W. E. Britton, New Haven, Conn.; T. J. Headlee, New Brunswick, N. J.; H. L. McIntyre, Albany, N. Y.; C. H. Hadley, Harrisburg, Pa.; E. N. Cory, College Park, Md.

Professor Neguib Iskander, Assistant Entomologist of the Ministry of Agriculture of Egypt, recently visited the Bureau of Entomology and some of its field stations to study fumigation methods, especially those used in the control of the insect enemies of citrus fruits.

At the annual meeting of the Board of Governors of the Crop Protection Institute, held at the Chemists Club, New York City, February 14, the following entomologists were present: E. D. Ball, W. E. Britton, G. A. Dean. M. D. Leonard W. C. O'Kane, P. J. Parrott, and A. Peterson.

Realizing the economic importance of farm birds in the control of insect pests, the Department of Entomology in the University of Missouri is offering a regular department course dealing with the study of birds and their value in the control of insect pests.

Dr. Philip Luginbill of the U. S. Bureau of Entomology received the Ph.D. degree at the George Washington University at its winter convocation on February 22. Dr. Luginbill is in charge of the Cereal and Forage Insect Laboratory of the Federal Bureau at Columbia, S. C.

Mr. E. Graywood Smyth, Special Field Agent, connected with truck crop insect investigations, Bureau of Entomology, for more than a year and a half, most of which time he spent in Mexico investigating parasites and natural enemies of the Mexican bean beetle, has returned to New York, having completed the temporary special work for which he was engaged.

Mr. T. E. Holloway, Bureau of Entomology, attended the annual meeting of the inspectors of the Mississippi Plant Board at Starkville, Miss., during December, and at the request of Professor Harned, gave brief talks on the sugar-cane moth borer and its control in Mississippi, and on miscellaneous sugar-cane insects.

Professor W. C. O'Kane gave an address on "Some New Facts About the Control of Nursery Pests" before the thirteenth annual meeting of the New England Nurserymen's Association, Boston, Mass., January 30, and at a tree worker's institute at New Haven, Conn., March 11 on "Some Insects Attacking Shade Trees."

Messrs. C. H. Popenoe, Sligo, Md., and J. E. Dudley, Jr., Madison, Wis., of the Bureau of Entomology attended the National Canner's Convention at Buffalo, N. Y., January 21–26. Mr. Dudley presented a paper on the control of the pea aphis and Mr. Popenoe had charge of an exhibit made by the Bureau.

The U. S. National Museum has recently temporarily assigned an additional room for use of the Bureau of Entomology, and the National Collection of Coccidae has been moved into it. Mr. Harold E. Morrison and staff will also occupy this room. Formerly this collection was housed in the Insectary of the Bureau.

Mr. E. A. McGregor, who was connected with the Bureau of Entomology for a number of years, has been reappointed and assigned to duty at Lindsay, Calif., where he will continue the field operations under way against the citrus thrips, work which was formerly conducted by A. J. Flebut, who recently resigned from the service.

A conference of field foremen engaged in gipsy moth work in New York and western New England was held at Albany, N. Y., January 17 and 18. This meeting was addressed by H. L. McIntyre who presided, A. F. Burgess, Melrose Highlands, Mass., W. E. Britton, New Haven, Conn., Drs. E. P. Felt and M. D. Leonard, Albany, N. Y.

Dr. Andrew Balfour, formerly Director of the Wellcome Research Laboratory, Khartum, Anglo-Egyptian Sudan, who worked for many years on medical entomology, especially sleeping sickness, and Colonel F. F. Russell, General Director of the International Health Board of the Rockefeller Foundation, New York, visited the Bureau of Entomology recently. They also viewed the insect collections in the United States National Museum.

On February 6, 7 and 8, Mr. Arthur Gibson, Dominion Entomologist of Canada, presided over a conference of Federal and Provincial game officials called by the Dominion Parks Branch of the Department of the Interior. This conference was attended by representatives of the various provinces interested in the conservation of wild life. It was held in the House of Commons at Ottawa.

According to *Science*, Messrs. Theodore R. Garner and Harold A. Jaynes of the Bureau of Entomology, planned to sail on March 4 from San Francisco for Kobé, Japan, to carry on research work in parasitology, with special reference to the Japanese beetle (*Popillia japonica*). After a year in Japan and Korea, they expect to continue for several years the study of allied parasites in China and India.

Mr. L. S. McLaine returned to Ottawa on January 7th, after spending his holidays in New York. During his absence he visited the headquarters of the Federal Horticultural Board in that city and through the courtesy of Mr. H. B. Shaw, in charge of the work, went into the system of handling permits, inspections, etc. Mr. McLaine also spent a day with the offiicals of the Federal Horticultural Board in Washington, D. C.

Professor Herbert Osborn of the Ohio State University visited the Sugar-Cane Insect Laboratory at New Orleans and took part in a conference on the control of the sugar-cane moth borer. Others at the conference were W. G. Taggart, director of the Sugar Experiment Station, Ed. Foster of the Nursery Inspection Service, W. G. Bradley, Entomologist of the Louisiana Stations, and T. E. Holloway and W. E. Haley of the Bureau of Entomology.

Recent visitors to the U. S. National Museum include: Mr. Henry Bird, Rye, N. Y.; Dr. M. D. Leonard, Albany, N. Y.: Dr. S. J. Hunter, Lawrence, Kan.; Mr. Arthur Gibson, Dominion Entomologist, Ottawa, Can.; Mr. A. J. Mutchler, American Museum of Natural History, New York City; Mr. M. C. Van Duzee, Buffalo, N. Y.; Mr. A. E. Miller, Wooster, Ohio, Mr. R. E. Tarbett, Texas; and Dr. Andrew Balfour, formerly Director of the Wellcome Research Laboratory, Khartum.

In the recent earthquake and fire in Japan, Dr. Inokichi Kuwana, the Director of the Imperial Plant Quarantine Station at Yokohama and the best known of the Japanese Economic Entomologists, lost his entire library and collection, together with the complete edition of a work upon Entomology which had just been published. The Doctor is, therefore, in great need of economic literature. Any such works which the economic entomological workers in this country could send him would in consequence be most welcome.

The following men of the division of cereal and forage insect investigations, Bureau of Entomology, are taking graduate work: W. H. Larrimer at Ohio State University, G. W. Barber at Harvard University, H. L. Sweetman at Iowa State University E. J. Udine at Montana State College. The following are planning to take work: W. J. Phillips at the University of Virginia, D. W. Jones and K. W. Babcock at Harvard University, F. W. Poos at Ohio State University, L. H. Patch at Massachusetts Agricultural College, and C. M. Packard at the University of California.

Entomologists of Ohio, Indiana, Illinois, Missouri, Kansas, Iowa, Minnesota, and Wisconsin, planned to meet in Columbus, March 6 and 7. The association

includes Federal entomologists located in the district as well as all state entomologists. The problems common to the section will be discussed and projects planned to cover all without needless duplication. Entomologists of Michigan and Kentucky have been invited to this conference because of their peculiar interests in the European corn borer and Mexican bean beetle, both of which are advancing into the district.

Mr. H. B. Peirson has recently been appointed Entomologist in the Forest Service, under the technical direction of the division of Forest Insect Investigations, utilizing cooperative funds supplied by Maine timberland owners. For several years Mr. Peirson has been serving as State Forest Entomologist in Maine under the direction of the State Forest Service, supported by the timberland owners. The present arrangement will make it possible for him to maintain closer relations with the Northeastern Forest Service Experiment Station and Represent the Bureau of Entomology in cooperative work at that station.

The Rhode Island Nurserymen's Association held a well attended meeting on February 6 at which there was a spirited discussion on various subjects relating to the nursery business, and particularly with regard to the operation of quarantines against New England because of the presence of the gipsy moth. The afternoon was devoted to a program consisting of : "Rose Growing for Nurserymen," by W. E. Craig of Massachusetts; "Propagating Evergreens," by H. H. DeWildt; and "New Insects of a Serious Nature Recently Introduced or Likely to Come into Rhode Island from Other States," by A. E. Stene.

The following State Entomologists visited Washington to attend the Japanese beetle hearing of the Federal Horticultural Board, January 4, 1924; George G. Becker, Little Rock, Ark.; E. N. Cory, College Park, Md.; S. B. Fracker, Madison, Wis.; P. A. Glenn, Urbana, Ill.; C. H. Hadley, Harrisburg, Pa.; T. J. Headlee, New Brunswick, N. J.; S. J. Hunter, Lawrence, Kans.; M. D. Leonard, Albany, N. Y.; and Frank N. Wallace, Indianapolis, Ind. The following also attended: Arthur Gisbon, Dominion Entomologist, Ottawa, Canada; L. S. McLaine, Chief, Division of Foreign Pests Suppression, Ottawa, Canada; Wilmon Newell, Plant Commissioner, State Plant Board, Gainesville, Fla.; and C. A. McCue, Director. Agricultural Experiment Station, University of Delaware, Newark, Del.

The Entomology Department at Montana State College has moved into its new quarters in Lewis Hall. The new structure is a five story building 135 by 65 feet, and is devoted entirely to the biological group of subjects, including the departments of Botany, Entomology and Zoology. The Entomology Department will have four laboratories for Experiment Station work, an insect collection room, an insecticide laboratory, an artists' room, photographic laboratories, offices and library. There are two student laboratories for entomology and two lecture rooms. The equipment includes also a refrigerating plant and temperature conditioning chambers. There are also laboratories and offices for beekeeping and rodent control.

An agreement has recently been signed by which the Bureau of Entomology, the University of Minnesota, and the Lake States Forest Experiment Station will work together in more extensive investigations of forest insects in the Lake States as a basis for their control. The investigations shall be planned, approved, and conducted jointly by the three parties to the agreement. With the precedent of the

enormous damage done to the tamarack by the larch sawfly and to the spruce and fir by the spruce bud worm and the recent appearance of serious infestations of the jack pine sawfly which threatens to wipe out forests of that species in the region, this start in a cooperative attack on the problems involved is most opportune.

On account of favorable weather conditions and the fact that several of the districts which were important breeding centers in the past were found to be clear of infestation by the brown-tail moth, the work in Nova Scotia this season has progressed much faster than usual. Up to February 2, only 57 nests had been found which is the smallest number collected in Nova Scotia since the work was first undertaken in 1907. The majority of the nests this year were taken at Bridgetown which locality has been an important breeding center for some years. Greater efforts than ever will be made to clean up Bridgetown this year. The general inspection of western Charlotte county, N. B., for the brown-tail moth was completed on January 26 by Messrs. Simpson and Reed. No infestation was discovered which is the record prevailing since 1917–18.

Mr. W. A. Ross of the Vineland Station Laboratory, Entomological Branch, Canadian Department of Agriculture, attended the annual meetings of the New York State Horticultural Society which were held in Rochester on January 15, 16 and 17. Many important and enlightening discussions took place dealing with entomological problems and the exhibits of spraying materials and spraying and dusting machinery were excellent. Mr. Ross took an active part in various disscussions including the grape leaf hopper problem. Under the auspices of the Welland Reforestation Committee a meeting was held in Welland on January 23 for the purpose of discussing the matter of reforesting waste lands. At this meeting Mr. Ross discussed his work in the Pelham district and emphasized the important association of the reclamation of neglected lands in the area infested by the rose chafer to the successful control of the pest. On January 24 and 25, Mr. Ross also attended Fruit Growers' meetings in Trenton and Brighton.

Announcement has just been made of the resignation of Dr. W. E. Hinds as Entomologist at the Alabama Experiment Station. On April 1 he will take up similar work with the Louisiana Experiment Station at Baton Rouge, La. Dr. Hinds has been located at the Alabama Station since 1907. During that time he has made special study of the control of insect pests attacking stored corn. This is one of the most important insect pests in the South and through these studies ways were found for saving millions of dollars each year to the corn growing areas of the South Atlantic and Gulf Coast States. In his work with the cotton boll weevil he has been one of the pioneers, having been in that work since 1902. He is at present Chairman of the Committee on Entomology of the Cotton Production Council of the Southern Agricultural Workers and also a Representative of the Southern Agricultural Workers on the National Boll Weevil Control Association. He has been President of the Association of Cotton States Entomologists since its organization in 1910. A very successful meeting of this Association was held at Birmingham, Ala., in January, last.

Mr. William D. Richardson, an amateur coleopterist of Fredericksburg, Va., died at the State Hospital at Marion, Va., October 31, 1923, after a long illness. After his return from service in France he donated most of his collection of beetles to

the National Collection, but retained the families Elmidae and Parnidae for a study which his illness made impossible. While on a visit to friends at the Musuem he told of the material he had collected during his military service along the Mexican Border and in France and of its bequest to the National Museum by a provision of his will, but having no entomological friends in Richmond who could understand his interests, only seven boxes, probably comprising all of his pinned specimens, were preserved from the cleaning of his room during his long confinement at the hospital. J. Bowie Ferneyhough of Richmond has kindly sent these boxes to the National Museum for safe keeping pending the legal settlement, but manuscripts and notes were not found. The Richardson collection is chiefly valuable for the fine specimens of small beetles collected at Fredericksburg, Va., between 1891 and 1904.

On November 28, 1923, Dr. T. E. Snyder of the Bureau of Entomology visited the Naval Aircraft Factory, U. S. Navy Yard, Philadelphia, Pa., to outline cooperative experiments in steaming, in kiln, lumber infested with Lyctus powder-post beetles. Various temperatures from 120° to 180° F., are to be tested to determine fatal temperatures. R. A. St. George supervised these steaming tests from December 11 to 14, at the Naval Aircraft Factory. Mr. St. George visited a wood-turning factory at Front Royal, Va., to determine the results of cooperative tests to prevent attack by wood-boring insects. Dr. Snyder inspected telephone poles in the vicinity of Norfolk, Va., December 15 and 16, to determine the distribution of and extent of damage by the northern Florida termite *Kalotermes approximatus* Snyder. This nonsubterranean wood-boring termite has not yet become a pest in Virginia. Species of *Kalotermes* so extensively damage the tops of telephone poles as to necessitate impregnating the entire pole, cross arms, etc., with coal-tar creosote. Dr. Snyder left Washington on January 24 for Ancon, C. Z., Panama, where tests are to be continued with wood preservatives to protect timber from attack by wood-boring insects, especially termites. By means of an agreement with Dr. Quaintance, Dr. Snyder will be greatly aided in this work through cooperation with J. Zetek.

During the Annual Farm Products Show Week, there was an informal gathering of entomologists working within the State of Pennsylvania, at Harrisburg, Pa., on January 23, 1924. The meeting was held at the offices of the Pennsylvania Bureau of Plant Industry, and 25 entomologists were present, all excepting one—Professor P. J. Parrott of Geneva, N. Y.—being entomologists working within the State of Pennsylvania. There were represented among the gathering the Bureau of Plant Industry, the Pennsylvania Department of Agriculture, the Pennsylvania State Experiment Station, the Extension Service of the Pennsylvania State College, the Federal Bureau of Entomology, and several commercial concerns. All of the men gathered here were particularly interested in economic entomology, and included men who were primarily interested in the following phases: fruit insects, field crop insects, vegetable insects, nursery insects, greenhouse insects, apiary investigations, nursery inspection, extension in entomology, forest insects, entomological collections, and medical entomology. After the general meeting the gathering adjourned to a local restaurant for supper. After supper a short business meeting was held and it was agreed to form an organization, the name adopted being the "Entomological Society of Pennsylvania," the membership to be open to any entomological worker in the State, not limited merely to professional workers. It was further agreed that there would be an Annual Round Up in Harrisburg at the time of the Annual Farm

Products Show with field gatherings from time to time as opportunity offered. The officers chosen were C. H. Hadley of the Pennsylvania Bureau of Plant Industry as President, and S. W. Frost of the Pennsylvania State College Experiment Station as Secretary. The following entomologists were present: H. D. Smith, P. R. Myers, C. C. Hill, C. F. Doucette, and J. L. King of the U. S. Bureau of Entomology; D. L. Van Dine, J. L. Horsfall, A. L. Strand, S. W. Frost, H. E. Hodgkiss and N. E. Phillips of the Pennsylvania State College; J. R. Stear, T. L. Guyton, Fred H. Worsinger, Jr., G. B. Stichter, F. M. Trimble, A. B. Champlain, A. B. Wells, F. L. Holdridge, H. B. Kirk, C. N. Greene and C. H. Hadley of the Pennsylvania Bureau of Plant Industry; T. T. Haack and J. K. Primm of the Sun Oil Company; and P. J. Parrott of the Agricultural Experiment Station, Geneva, N. Y.

A conference of North Central States Official Entomologists was held at the Ohio State University, Columbus, Ohio, March 6 and 7, 1924. This conference was for the purpose of correlating the research and extension programs in the north central states. Projects in progress, or to be undertaken, were discussed. The European Corn Borer program was of most general interest of the topics under discussion. Plans for investigation and control work in Ohio were discussed. Entomologists of the States of Ohio, Indiana, Illinois and the Bureau of Entomology will unite to carry out an intensive corn borer clean-up campaign. This will be made in northern Ohio counties April 14 to 26. Among other subjects discussed were: Hessian fly and chinch bug problems, oil emulsions, cyanide and nicotine dusts, potato leaf-hopper control and the Mexican bean-beetle. H. A. Gossard was chosen Chairman and T. H. Parks Secretary of this meeting. The following entomologists were present: *Ohio:* D. M. DeLong, Richard Faxon, H. A. Gossard, J. S. Hine, J. S. Houser, L. L. Huber, C. H. Kennedy, R. C. Osburn, T. H. Parks; *Indiana:* J. J. Davis and F. N. Wallace; *Illinois:* W. P. Flint; *Wisconsin:* E. L. Chambers; *Michigan*: R. H. Pettit; *U. S. Bureau of Entomology*: E. G. Brewer, D. J. Caffrey, Geo. A. Dean, W. H. Larrimer, F. W. Poos, G. A. Runner, A. F. Satterthwait, L. H. Worthley; *Graduate Students at the Ohio State University*: S. W. Bilsing, J. W. Bulger, C. R. Cutright, W. S. Hough, J. N. Knull, H. C. Lewis, C. R. Neiswander and A. N. Tissot.

Dr. J. F. Illingworth, formerly professor of entomology in the University of Hawaii, after spending four years in Australia on a special investigation of the pests of sugar cane for the Queensland Government, returned to his home at Honolulu. There he was appointed research associate in entomology at the Bishop Museum, which is his permanent address. At present Dr. Illingworth is engaged as specialist on the Green Japanese Beetle problem, by the U. S. Department of Agriculture, and is traveling in the Orient. The past season was spent in a general survey of this pest in Japan, where, unfortunately, he lost all his equipment in the Yokohama catastrophe. Since Dr. Illingworth is to investigate Chinese territory during the coming season, he has selected Shanghai as temporary headquarters, care of the American Consul.

NOTES ON HORTICULTURAL INSPECTION

Mr. Chester A. Davis, Plant Quarantine Inspector at Philadelphia, has been transferred to Boston, reporting for duty on March 10.

Mr. C. W. Stockwell of the Japanese Beetle Laboratory at Riverton, N. J., was called to Washington for a conference on March 1.

A live Alfalfa Weevil, *Phytonomus posticus* (Gyll.), was taken recently in packing material from a registered package coming from Germany, by Mr. George Compere in San Francisco.

Mr. William W. Chapman, a recent graduate of the Mississippi State Agricultural and Mechanical College, has been appointed to the position of Plant Quarantine Inspector, with headquarters at Philadelphia.

Dr. Norman Perrine of the Washington force has just returned from a trip to Boston, where he was making tests of the efficiency of gas generating apparatus used in cotton fumigation.

Mr. J. A. Stevenson has returned from Cuba, where he made an investigation of the potato disease on the Island to determine the advisability of permitting the shipment of potatoes to the United States.

Mr. William V. Reed, formerly State Entomologist of Georgia, has been appointed to the position of Plant Quarantine Inspector with headquarters at New Orleans, La. He took up the work at that Station on March 10.

Mr. A. G. Albrecht, a Plant Quarantine Inspector of the Federal Horticultural Board, has been transferred from New Orleans to Philadelphia to take up the duties formerly performed by Mr. Chester A. Davis, who was transferred to Boston.

The Spiny Citrus White Fly, *Aleurocanthus woglumi* Ashby, has been intercepted on Spice leaves from Nassau, Bahamas, and on Citrus from Cuba. The latter interception was made at Jacksonville in a registered mail package destined for Ashville, N. C.

Mr. Thomas J. Baker, formerly a Quarantine Inspector of the State of Florida and recently Plant Quarantine Inspector for the Federal Horticultural Board at New Orleans, has been placed in charge of the inspection work at Astoria, Oregon.

Messrs. J. A. Stevenson and W. T. Owrey of the Washington office recently completed an inspection trip to points in Florida and Georgia. They visited several field stations of the Bureau of Plant Industry and inspected all plants intended for distribution.

A species of *Balaninus* has been frequently taken at the Inspection House in shipments of Chestnuts and *Castanopsis* sp., arriving from China. This insect is similar in appearance to the smaller Chestnut Weevil, which is common in this country.

Mr. William F. Freeman, who has been in charge of the port of Astoria, Oregon, has been transferred to New York. Mr Freeman will have direct charge of the inspection work in New York City under the supervision of Mr. Shaw.

Mr. Alva C. Hill has been appointed to the position of Plant Quarantine Inspector

with headquarters in New York City. Mr. Hill is a graduate of the Missouri Agricultural College and has taken graduate work at the Iowa State College of Agriculture.

Mr. Randolph W. Nicaise has been appointed Plant Quarantine Inspector in the Federal Horticultural Board with headquarters at New York. Mr. Nicaise was formerly employed by the Bureau of Entomology in Boll Weevil work and later by the Federal Horticultural Board in the Pink Boll Worm Eradication work.

A Scolytid beetle, *Coccotypes* sp., has been taken recently in several lots of palm seeds received at Washington for inspection, which were destined for points in the South. The beetle works as a stored product pest, entering the seeds from the outside and breeding and feeding within the kernel.

Mr. J. T. Rogers, in charge of the inspection work at Charleston, S. C., recently intercepted the Turnip Gall Weevil, *Ceutorhynchus pleurostigma* Marsh, in turnip roots from Newcastle, England. This insect is treated in a paper published by P. B. Isaac in the "Annals of Applied Biology," Vol. 10, 1923, page 170.

Mr. Thomas A. Arnold, Plant Quarantine Inspector at El Paso, in making an examination of the bedding carried by a Mexican coming across the Border into Texas, found the larva of an insect crawling on the outside of the roll. The larva was determined by Mr. Heinrich of the Bureau of Entomology as the Pink Boll Worm.

Dr. William Mann of the Bureau of Entomology left Washington the latter part of January *en route* to Colombia, South America, in the interest of the Federal Horticultural Board. He will make an investigation of the insects liable to be imported into the United States, which attack fruits and vegetables, paying particular attention to the fruit flies. From Colombia, he will proceed northward, passing through Panama and into the Central American States.

A package of cotton from Hawaii addressed to a firm at Calexico, Calif., was turned over to Mr. O. A. Pratt, Plant Quarantine Inspector at that point, immediately upon its receipt by the firm. Mr. Pratt writes that while the seed showed abundant evidence of insect injury, he was able to find only one live larva, which he cyanided and sent to Washington. The insect was determined by Mr. Heinrich as the Pink Boll Worm.

Apicultural Notes

The California State Beekeeper's Association held its 33rd annual meeting during holiday week at Sacramento.

The short course on beekeeping at the Agricultural College, Fargo, N. D., was given in February. From 15 to 25 attended.

Mr. J. I. Hambleton, Bureau of Entomology, was one of the speakers at the meeting of the Pennsylvania State Beekeeper's Association at Harrisburg, Pa., January 24 and 25.

Dr. E. F. Phillips will represent the Apiculture Section of the Association of

Economic Entomologists at the Seventh International Apicultural Congress to be held in Quebec, September 1 to 4.

A short course and conference for Indiana beekeepers was held at Purdue University, February 11–14. Among the speakers were Dr. E. F. Phillips, Geo. S. Demuth and Professor John J. Davis.

The first step in the formation of a permanent beekeeper's association in Arkansas was taken on February 11 when the new organization was completed. George G. Becker, of Little Rock, was chosen secretary.

The annual meeting of the Ohio State Beekeeper's Association was held at the Ohio State University, Columbus, February 7 and 8. F. B. Moore was elected President and Miss Florence Naile, Columbus, Secretary-Treasurer.

The proceedings of the Sixth International Apicultural Congress held at Marseilles, France, September 1922, have at last appeared. All papers are given in French and copies may be had from the Secretary of the Congress, Léon Tombu, 185, rue Gaucheret, Brussels, Belgium.

A new bee journal has made its appearance and is called the "Midwest Farm Beekeeper." J. W. Kuhn of Belleville, Kansas, is the Editor. According to the Editor, its field is "the Great Central West from the Mississippi to the Mountains and Beyond."

The Tennessee Beekeeper's Association held its annual convention at Nashville on February 1, over 100 being in attendance. This was one of the best meetings the association ever held. Mrs. Grace Allen, Nashville, was elected President and Professor G. M. Bentley, Knoxville, was reëlected Secretary-Treasurer.

Professor F. B. Paddock, State Apiarist of Iowa, is scheduled for two radio talks from the Ames Station, WOI, 360 meters. These talks will be given at 12:40 noon, with dates and subjects as follows: March 28, "Spring Care of Bees," May 23, "Preparations for the Honey Crop."

The fifteenth annual meeting of the Maryland State Beekeeper's Association was held in the Southern Hotel, Baltimore, on January 9. Addresses were made by Dr. E. F. Phillips and J. I. Hambleton of the Federal Bureau of Entomology, and by M. W. James, Baldwin, Md., and George Harrison Jr., University of Maryland.

The annual meeting of the Kansas State Beekeeper's Association was scheduled to be held at Topeka, February 4 and 5, then adjourn to meet on the 6th and 7th at the apiary department of the Agricultural College at Manhattan. Mr. O. F. Whitney, Topeka, is the secretary of this association.

A gathering of Fargo, N. D., beekeepers was held February 15. Mr. L. T. Floyd of Winnipeg, who was in Fargo to give lectures at the short course at the Agricultural College, told about the recent beekeeper's meeting of the Manitoba association, and Mr. O. F. Miller related some of his observations on California beekeeping.

Mr. R. B. Willson, Extension Specialist for New York State, broadcasted a talk on the uses of honey from Station "WEAF," New York City, on the evening of February 27. During the course of his talk he mentioned Farmers' Bulletin 653, "Honey and Its Uses in the Home" and since that time has been overwhelmed with requests for the bulletin.

Dr. F. Vincens has been appointed by the French Government to investigate the diseases of bees in that country, especially those of the adult bee. The laboratory for

this work has been established at Cagnes, Alpes-maritimes, in southern France. Dr. Vincens has recently published two short papers in the *Comptes rendus* of the Paris Academy of Sciences on two fungi which appear to be pathogenic to adult bees.

At the annual convention of the American Honey Producers' League, held in Chicago on January 24 and 25, Mr. B. F. Kindig, chief apiary inspector of Michigan, was elected president and Mr. Colin P. Campbell of Grand Rapids, Michigan, as vice-president. The executive committee re-appointed S. B. Fracker, Madison, Wisconsin, as secretary.

Dr. M. C. Tanquary, Chief of the Division of Entomology, Texas Agricultural Experiment Station and State Entomologist, has resigned, effective May 1, to enter a commercial apiary business extending into several states. He has held this position in Texas for four years, preceding which he was Assistant Professor of Entomology at the Kansas Agricultural College and Assistant Entomologist of the Experiment Station. Dr. Tanquary is automatically succeded by H. J. Reinhard, who has been a member of the staff for more than eight years.

In connection with Farmers' Week at Ames, Iowa, a beekeeping short course was given under the direction of Professor F. B. Paddock. Outside speakers included G. H. Cale, of Hamilton, Illinois, who gave several talks on general beekeeping methods; S. B. Fracker, of Madison, Wisconsin, who spoke on marketing, on bee disease eradication, and on the work of the American Honey Producers' League; and Professor Francis Jager, St. Paul, Minnesota, who discussed the subjects of queen rearing cellar wintering, and European beekeeping.

Mr. Willis J. Nolan of the Bureau of Entomology returned January 31 from his European trip. While abroad he visited the newly established apicultural experiment station of the Republic of Czecho-slovakia, located at Prague, and in charge of Dr. A. Schonfeld. The station is located in the suburbs of the city and occupies a large estate with excellent buildings. The work is just being begun and will include a study of the diseases of bees in that country. He also visited Vienna where he spoke before one of the beekeeping societies of the city and met a number of the prominent beekeepers. He also visited the Bakteriologische Anstalt at Liebefeld near Bern, Switzerland, where Dr. Robert Burri who worked on bee diseases some years ago is director. The bee disease work there is now in charge of Dr. Otto Morgenthaler. Mr. Nolan did not go into Germany as he had planned because of the disturbed economic conditions of that country.

Federal cooperation with the states in an extensive American foulbrood eradication campaign on the area cleaup method will be asked of Congress by the American Honey Producers' League, according to action taken at the annual convention. A steering committee, consisting of B. F. Kindig, chairman, S. B. Fracker and E. R. Root, and two others yet to be appointed, has been organized to sponsor the campaign and a large federal appropriation will be asked for the purpose. It is understood that the work will be done county by county and state by state in accordance with the successful area clean-up campaigns now in progress in several states, and that the areas freed from disease would be protected from the introduction of infected material by federal authority. The promise of the active support of the United States Department of Agriculture is assured, according to Dr. E. D. Ball, who has discussed the subject in several public addresses and personal conferences, and the project is also advocated by the Bee Culture office of the Bureau of Entomology.

PACIFIC SLOPE NOTES

Dr. William Moore of the American Cyanamide Company visited southern California after the Cincinnati meetings, returning to New York via New Orleans and Washington.

Mr. Neguil Iskander, Assistant Entomologist in the Ministry of Agriculture, Cairo, Egypt, spent several weeks in California, investigating methods of insect control. He was particularly interested in fumigation with liquid hydrocyanic acid gas.

Mr. A. J. Flebut, who has been in charge of the Citrus Thrips Project, with headquarters at Lindsay, Calif., has resigned, effective January 1, 1924, to accept a position with the General Chemical Company, San Francisco. It is understood that he will have charge of the insecticide department of this company, succeeding the late S. W. Foster.

NOTES ON MEDICAL ENTOMOLOGY

Professor Herbert Osborn, of Ohio State University, is spending a few weeks visiting in southern California. Recently the entomologists at the Citrus Experiment Station at Riverside, Harold Compere, A. J. Basinger and Harry S. Smith, arranged a collecting trip for Professor Osborn and Professor Lawrence Bruner to Palm Springs Canon in the Colorado Desert. Collecting was rather poor owing to the abnormally dry season, but some interesting species were secured.

According to the *Official Record*, Dr. W. V. King in charge of investigations of insects affecting the health of man at Mound, La., has experimented in dusting swamps with an airplane to kill mosquitoes. The dust consisted of Paris green heavily diluted with Tripoli earth, and similar materials have been recommended in certain cases by the United States Public Health Service. The airplane offers simply a wholesale method of application, and proved very successful.

Professor H. J. Quayle, of the Citrus Expermiment Station at Riverside, California, has returned from a trip around the world. Professor Quayle carried on some interesting demonstrations of the use of calcium cyanide in Australia for control of the red scale of citrus. He also demonstrated the use of this material for control of the rabbit plague in that country, where it gives promise of much success. Some time was spent in Spain in an investigation of citrus insects and arrangements were made for the Spanish Government to secure beneficial insects from California, through Dr. L. O. Howard and Harry S. Smith.

The eleventh annual meeting of the New Jersey Mosquito Extermination Association was held at the Hotel Traymore in Atlantic City, February 13, 14, and 15, 1924. Dr. L. O. Howard, Chief of the Bureau of Entomology, U. S. Department of Agriculture, gave an address on some recent developments in anti-mosquito work and Major Joseph Le Prince, Senior Sanitary Engineer, U. S. Public Health Service, gave an excellent account of the anti-mosquito work in the South. The New Jersey State Federation of Women's Clubs of 40,000 members was represented by Mrs. Clayton B. Lee, Mrs. Bertha H. Boynton and Mrs. Charles A. Prickett. Dr. Jacob G. Lipman, Director of the New Jersey State Experiment Station, gave a review of the anti-mosquito legislation and an account of the present attempt to repeal all mandatory state laws. Inasmuch as the collection of funds for mosquito elimination

work in New Jersey is mandatory on the county free-holders, he urged that immediate steps be taken to prevent the passage of such an act. An interesting paper on the influence of various substances as attractive and repellent agents upon behavior of mosquitoes was presented by Dr. William Rudolfs of the New Jersey Experiment Station. Papers were read covering the progress of anti-mosquito work in New Jersey, Connecticut and New York. Ten counties in New Jersey engaged in anti-mosquito work were represented as follows: Atlantic, Fred A. Reiley and Hubert Somers; Essex, James E. Brooks and Abram H. Cornish; Passaic, Frank Wilkinson; Bergen, Alfred J. Tipping; Hudson, Lewis E. Jackson; Union, Louis Richards; Middlesex, William Dinwiddie; Monmouth, Dr. G. Van Voris Warner; Ocean, Robert F. Engle; Cape May, Alan de P. Ewing. A paper by Robert C. Botsford on the Connecticut work was illustrated by lantern slides. Mr. William De Mott presented a paper on the anti-mosquito work in Nassau County, Long Island. The subjects of oiling, larvicides, ditching and ditch cleaning, machinery, education in public schools, legislation and others were discussed and illustrated. The convention was well attended and thoroughly interesting and instructive.

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SOIL INSECTICIDE INVESTIGATIONS AT THE JAPANESE BEETLE LABORATORY DURING 1923

BY B. R. LEACH, W. E. FLEMING and J. P. JOHNSON[1]

ABSTRACT

The experimental work thruout the year with *Popillia japonica* has been carried on with the object of evolving methods of chemically treating the soil about the roots of such plants as conifers, boxwoods, azaleas, rhododendrons, hydrangeas, ferns, blueberries and perennials for the control of the soil stages of the Japanese beetle. Emulsions of carbon disulfide and wormseed oil have proved satisfactory in these connections and are now in use by the local nursery and greenhouse concerns.

The Japanese beetle is now gradually spreading over an area in New Jersey and Pennsylvania within which is centered a large proportion of the nation's nursery interests. Since the insect inhabits the soil throughout the greater part of its life and is found about the roots of plants almost anywhere within this area, a quarantine has been established prohibiting the shipment of soil, or plants with soil about their roots to points outside unless freed of possible infestation. Under these circumstances the experimental work during the past four years has been carried on along fundamental lines with the object of devising various methods of soil treatments which would cover the treatment of different types of nursery stock grown within the area. In addition to the above problems, an important side line has been the study of controlling the larvae in specialized areas of turf, such as lawns and golf greens.

During these four years the writers have tested practically every chemical which offered possible merit as a soil-insecticide. Included in this broad survey of the chemical field is a two-year study of organic compounds made for the specific purpose of finding new soil insecticides. The work, which will be published in the near future, indicates that no

[1]Contribution from the Japanese Beetle Laboratory, Bureau of Entomology U. S. D. A. in cooperation with the Departments of Agriculture of the States of New Jersey and Pennsylvania.

compound is equal to carbon bisulphide as a general soil insecticide for the control of the egg, larva, and pupa. Considering its toxicity to the insect, it has the least deleterious action upon plants of any compound known when properly handled. Under the circumstances and in view of the lack of other chemicals of all-around value, the work has unavoidably centered upon a fundamental study of this compound and its effect upon the insect, the soil, and the plant.

One of the first problems arising in connection with the Japanese beetle project consisted in devising a method of freeing the soil (destined for greenhouse potting purposes) of any stage of this insect. A complete report[2] of this work has been published, embracing a study of the fumigation of soil with carbon bisulphide in a closed container. The results indicate that the treatment of loose soil in a tight container by the interspersion of definite injections of liquid carbon bisulphide is a cheap and efficient method for this purpose when used at the rate of 13 fluid ounces per cubic yard of soil. It was found that the diffusion of the carbon bisulphide vapors throughout the soil varied directly with the depth from the surface of the soil and inversely with the lateral distance from the point of injection. The soil type when the soil was thrown loosely into the fumigating chamber was not a limiting factor. Soil moisture became a limiting factor when it approached the saturation point; the soil temperature impaired the efficiency of the method when it fell below 50° F. When used at the above rate, the treatment did not affect the subsequent growth of herbaceous plants. The method is now in general use by the nurseries within the infested area. In the same way as above a study was made of the fumigation of plants, with balls of earth about their roots, in closed containers. No difficulty was encountered in killing any insects present (aside from those in puddled soils) but the aerial portions of the plants did not survive the treatment.

When carbon bisulphide was injected into the soil of potted plants or about the crown of plants growing in the nursery row in concentration heavy enough to secure 100 per cent control, the plants were injured with the one outstanding exception of Japanese azalea.

In view of the above results the writers began a series of fundamental experiments involving the use of carbon bisulphide with water as a carrying agent. It was found that 100 per cent control could be secured in practice but the mixture of carbon bisulphide and water was uncertain, due to the dependence of the concentration on the temperature of the

[2]Fleming, W. E. Fumigation of potting soil with carbon bisulfide for the control of the Japanese beetle. *In* N. J. Agr. Exp. Sta. Bul. 380.

water and the degree of agitation while preparing the solution. In view of this incompatability the writers carried on an extensive study of the emulsification of carbon bisulphide in order that the dosage might be controlled. The work involved the testing of the hydrophile colloids as emulsifying agents. It was found, in common with other investigators on this subject, that soap was by far the best emulsifying agent—especially the rosin-fishoil soaps. In the absence of standard brand soaps a stable emulsion can be made by the use of sodium or potassium oleate, or some other higher fatty acid.

With carbon bisulphide, emulsified by these methods and capable of being measured accurately and dispersed in water, the compound was tested upon various types of plants which were quarantined or in danger of being quarantined. The work, in addition to the study of the factors influencing the larval kill in the soil, included the experimental treatment of French hydrangeas, Japanese azaleas, rhododendrons, blue berries, ferns and other plants. It was found that plants in general would withstand a dose of the emulsified compound greater than that required to control the insects present. In the case of French hydrangeas a concentration of 0.5, 0.625 cc. of emulsified carbon bisulphide per liter of water controlled the insect in the soil when a volume of solution equal to one-half the volume of the treated soil was applied. The plants were growing in a sandy soil low in organic content and were treated by placing galvanized iron collars in the soil, applying the required amount of solution and allowing it to drain into the soil. At the end of 48 hours, the plants were dug, potted in wooden tubs and placed in the greenhouse. The tops of the plants remained normal while the feeding rootlets were sheared off by the action of the chemical. Within two weeks the plants had replaced these feeding rootlets and resumed a normal growth. In other words the plants experienced a temporary check in growth due to the action of the compound on the roots but rapidly recovered and resumed growth with a varying degree of stimulation.

In the case of Japanese azalea, rhododendron, blue berry, fern and other ericaceous plants which prefer an acid soil containing an abundance of peat, it was found that the amount of emulsified carbon bisulphide necessary to secure complete insect mortality depended upon the amount of organic matter present and that in every case the plant had greater resistance than the insect. Employing this method the writers have to date successfully treated 1,500 cibotium and aspidium ferns belonging to one of the local nurseries and valued at $10,000. Experimental data is now at hand to insure the successful treatment of azaleas, rhododendrons,

blue berries, hydrangeas, ferns and other similar potted plants during the next growing season. A detailed report of this phase of the work is now in preparation and will be submitted for publication in the near future.

The same general scheme has been followed experimentally in the treatment of evergreen nursery stock such as boxwood, pine, spruce, hemlock, arborvitae, retinispora, yew, etc. The work has been done under nursery conditions and the results indicate that the method will have considerable application in the treatment of this type of nursery stock as grown in the infested area. The aerial portion of the plant is uninjured and the feeding roots are rapidly replaced. Early and late fall treatments have been made and will be continued during the next spring and summer.

As indicated above, the methods evolved all necessitate the treatment of the plant by pouring the toxic liquid on the surface of the soil and allowing it to percolate thru the soil mass, the plants being either in pots or growing in the field. Considerable experimental work[3] has been done in respect to digging infested plants, wrapping them in burlap, and dipping them in the toxic solutions. The experimental results indicate that the soil absorption and possibly some other soil phenomena interfere with the action of the toxic material under these conditions. Considerable work is now being done along these lines.

While the experimental work to date involving the dipping of large balls of soil has been negative in character, it has been found that the dipping method has a considerable application in the treatment of matted and hollow rooted plants such as phlox, iris, and peony where only small amounts of soil are present. In this connection the carbon bisulphide emulsion dip has been applied to the treatment of peonies and American wormseed oil emulsion dip to the treatment of Japanese iris, phlox, hemerocalis, sedum, etc. During the past two years, the writers have treated 75,000 plants of this nature grown by two local nurseries and valued at $25,000. In view of the fact that large acreages of these types of plants are grown in this immediate vicinity, it is very probable that this method will have a large application. The results of this phase of the experimental work have been submitted to the Department for publication.

Aside from these phases of the work involving the treatment of nursery stock, the problem has arisen of controlling the larva in lawns and golf courses where it is frequently present in such large numbers

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[3]Leach, B. R. and Thompson, J. W. Soil treatment to control the Japanese beetle larvae about the roots of coniferous plants. *In* Soil Sci. 12, 43-59.

that the turf is severely injured and often killed outright. Experimental work along these lines has been conducted during the past three years and the results have been published from time to time.[4] During August and September of this year, the writers treated the 27 greens of two local golf courses which were heavily infested and severely damaged by this insect. A complete report of this phase of the work has been published in the October 1923 number of the Bulletin of the Green Section of the United States Golf Association.[5] The results indicate that from the standpoint of cost and efficiency, the method will have a considerable application in the treatment of such valuable areas of turf as lawns and golf greens.

In connection with growing potted plants, it is often desirable to have small areas of soil such as cold frames, etc. free of larval infestation in order that these potted plants may be plunged therein. Experimental work conducted during the past three years indicate that soil treated with acid arsenate of lead at the rate of 1,500 pounds to the acre, the material being thoroughly worked into the soil to a depth of 4 inches, will kill the larva present within a period of two weeks, depending upon the soil temperature. The method is now in use within the infested area. Experimental results indicate that the majority of plants are very sensitive to arsenic but of the hundred odd varieties of plants tested in this connection there are several outstanding examples of plants which will grow in soil treated at the above dosage of lead arsenate equally as well as in the untreated soils. The method has however a limited application in this respect and for this reason the writers have been carrying on experiments during the past two years with the object of coating the individual particles of the lead arsenate with some material which will preserve the lead against soil action and thereby protect the toxic properties until it is taken into the stomach of the larva. This work is now being continued along these lines with several definite leads in sight.

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[4]Leach, B. R. The Japanese beetle in relation to golf courses. 1921. *In* Bul. Green Sect. U. S. Golf Assoc. 1, no. 10, 210–211.

Leach, B. R., and Thomson, J. W. 1923. A control for the Japanese beetle larvae (Popillia japonica Newm.) in golf courses. *In* Jour. Ec. Ent. 16, 312–314.

Leach, B. R., and Thomson, J. W. A control for the Japanese beetle larvae (Popillia japonica Newm.) in golf greens. *In* Bul. Green Sect. U. S. Golf Assoc. 3, no. 6, 173–174.

[5]Leach, B. R., and Johnson, J. P. 1923. The Japanese beetle; its life-history and control in golf greens. *In* Bul. Green Sect. U. S. Golf Assoc. 3, no. 10, 262–268.

SELECTIVE PARASITISM BY *TIPHIA* SP.[1]

By H. A. JAYNES, *Assistant Entomologist*, and T. R. GARDNER, *Junior Entomologist, United States Department of Agriculture*

ABSTRACT

It has been observed during the past several years that the larvae of *Ochrosidia immaculata* became very numerous on a golf course in the vicinity of Moorestown, N. J. Within the past two years, the abundance of the larvae has been reduced approximately 95 per cent. by a native species of fossorial wasp belonging to the genus *Tiphia*. In the same manner the parasite increased in numbers and as the abundance of the host was reduced the numbers of the parasite decreased nearly 95 per cent. At the same time a related Scarabaeid, *Popillia japonica*, became very numerous in the same locality. Under conditions in the field only two *Popillia* larvae were found to be successfully parasitized by the native *Tiphias*. Experiments which were conducted indicated that the female *Tiphia* deposited her eggs, by preference, on the *Ochrosidia* rather than on *Popillia* larvae. The life histories of *Ochrosidia immaculata* and *Popillia japonica* are similar in this region, but the former larvae are larger than the latter, when both are full grown. Nevertheless during the latter part of August, when the *Tiphias* are present, many *Popillia* larvae have reached the third instar in their development; while many *Ochrosidia* larvae are in the second instar and are smaller than the *Popillia* larvae which have reached the third stage.

It is evident that, at present, this species of *Tiphia* is selective in its preference for its native host, but since it is possible for some individuals to develop successfully on the *Popillia* grubs, it is possible the *Tiphias* may develop a strain which will become parasitic on this introduced species.

For the past three seasons while studying native species of insects likely to become parasitic upon the larvae of *Popillia japonica*, several interesting points were observed relative to the parasitism of native Scarabaeid larvae. Most of our field observations were confined to an area of three or four square miles in the vicinity of Moorestown, N. J. During the summer of 1921, there was an infestation of *Ochrosidia (Cyclocephla) immaculata* on the Moorestown Golf Course. There were not enough larvae present to cause noticeable injury to the sod. The number of Japanese beetle larvae present was small since this territory had been infested for less than two years. Although search was made for native parasites, particularly species of *Tiphia*, none was found at this time.

ABUNDANCE OF TIPHIAS AT MOORESTOWN, N. J., IN 1922

In the summer of 1922, on the same course, it was noticed that areas of sod were loose and could be easily pulled up. Later in the season the grass died and turned brown. This condition of the sod was caused by

[1]Contribution from the Japanese Beetle Laboratory, Riverton, N. J.

the feeding of a large number of *Ochrosidia* larvae upon the grass roots. A few *Popillia* larvae were found at this time but not in sufficient numbers to cause damage to the sod. Thirty-eight female *Tiphia*[2] were collected in the vicinity of Moorestown at this time and placed in tins with *Popillia* larvae. The *Tiphia* laid 72 eggs, all of which they placed dorsally between the second and fourth segments. Several of these eggs hatched and the larvae partially developed; but with one exception never became sufficiently matured to spin perfect cocoons. One *Popillia* larva, upon which a *Tiphia* larva was feeding, was also found in the field. The parasite was situated between the second and third dorsal thoracic segments, and developed sufficiently to spin a perfect cocoon. This was the first case known of a Japanese beetle larva being parasitized in the field by a species of *Tiphia*.

In the fall of 1922, several diggings were made to ascertain the number of larvae present in the area where the injury to the sod has been observed and in adjacent areas. The area of each digging was usually one square yard made in representative portions of the field. It was found that there was an average of 151 *Ochrosidia* larvae, 8 *Popillia* larvae and 44 *Tiphia* cocoons to each square yard. Finding *Tiphia* cocoons at this time indicated that the adults were present in considerable numbers during the summer although none was collected in this particular locality except on wild carrot blossoms bordering the course.

Experiments and Observations in 1923

In the early spring of 1923, it was found that the number of *Popillia* larvae and *Tiphia* cocoons was about the same as in the fall although the *Ochrosidia* larvae were less numerous due to winter kill and disease, the highest mortality being found in the areas where the dead grass had been removed by rakings. At this time cocoons were found as numerous as 114 to each square yard, while there were only 56 *Ochrosidia* larvae in the same area. In another square yard, 27 cocoons and 211 *Ochrosidia* larvae were found. On further diggings over 3,000 cocoons were obtained at the Moorestown Golf Course in an area of 60 to 70 square yards. Finding such a large number of *Tiphia* cocoons is an unusual occurrence.

Experiments were conducted to further determine whether the *Tiphias* would parasitize and successfully develop on the larvae of *Popillia*. The usual method of rearing the parasite was to place a single

[2]Most of these are *T. punctata* as far as we know, but it is very probable that at least another species or two may be present.

fertilized female *Tiphia*, in a six ounce salve-tin partially filled with soil in which were placed three *Popillia* grubs. Daily examinations were made and those larvae on which eggs had been deposited were removed to individual tins and fresh grubs placed in the tin with the adult parasite. From a total of 363 female *Tiphias*, 250 of which were reared and 113 collected in the field, only 25 eggs were deposited on *Popillia* larvae. These were placed on the dorsal side usually between the third and fourth segments. From these only one developed sufficiently to start spinning a cocoon. It died, however, before the cocoon was completed. A large cage was built in which was placed about four inches of soil covered with sod and well stocked with third-instar *Popillia* larvae. Over 100 male and female *Tiphias* were placed in this cage. Several plants of *Cassia chamaecrista* L. were transplanted to the cage in order that the adult parasites might obtain their usual food from the extra-floral nectaries which occur on these plants. Later, upon examination, not a single parasitized larvae or cocoon was found, which indicates that this species of *Tiphia* does not readily attack or develop on *Popillia japonica*. Also it was observed in the experiments that when an adult female *Tiphia* was placed in a tin containing three or four *Popillia* and only one *Ochrosidia* larvae, the egg or eggs laid would invariably be placed on the *Ochrosidia* lavra. This year, however, another *Popillia* larva was found in the field bearing a *Tiphia* larva on its dorsal segments. This parasite developed and formed a cocoon.

The latter part of August, the male *Tiphias* were first found in small numbers. They later increased in abundance so that in making sweepings with the net, hundreds could be collected. No females were found until several days after the meals became numerous. They were then obtained in small numbers, later increasing, but never becoming as numerous as the males.

In the fall of 1923, several diggings were made and an average of only 11 *Ochrosidia* larvae to the square yard was found. In some plots none was present at all, while the most found in any single square yard was 25. This was a decided decrease in number as compared with last year. However, the number of *Popillia* larvae was decidedly increased to an average of 142 to each square yard, and in one plot, nearly 250 larvae were found. In regard to the *Tiphias*, cocoons were very scarce, averaging only 2 to each square yard.

Comparing the figures obtained from the diggings made in the autumn of 1922 and autumn of 1923, it was found that in the latter season, the number of *Ochrosidia* larvae was reduced 93 per cent, and the number of

Tiphia cocoons was likewise reduced 95 per cent; while the number of *Popillia* larvae was increased 94 per cent. It might at first be assumed that the *Ochrosidia* larvae were reduced entirely by parasitism. This of course was the largest factor causing the reduction; but disease and winter kill also helped in the decrease as was before mentioned.

Conclusions

It has been observed during the past several years that the larvae of *Ochrosidia immaculata* became very numerous on a golf course in the vicinity of Moorestown, N. J. Within the past two years, the abundance of the larvae has been reduced approximately 93 per cent by a native species of fossorial wasp belonging to the genus *Tiphia*. In the same manner the parasite increased in numbers and as the abundance of the host was reduced the numbers of the parasite decreased nearly 95 per cent. At the same time a related Scarabaeid, *Popillia japonica*, became very numerous in the same locality. Under conditions in the field only two *Popillia* larvae were found to be successfully parasitized by the native *Tiphias*. Experiments which were conducted indicated that the female *Tiphia* deposited her eggs, by preference, on the *Ochrosidia* rather than on *Popillia* larvae. The life histories of *Ochrosidia immaculata* and *Popillia japonica* are similar in this region, but the former larvae are larger than the latter, when both are full grown. Nevertheless during the latter part of August, when the *Tiphias* are present, many *Popillia* larvae have reached the third instar in their development; while many *Ochrosidia* larvae are in the second instar and are smaller than the Popillia larvae which have reached the third stage.

It is evident that, at present, this species of *Tiphia* is selective in its preference for its native host; but since it is possible for some individuals to develop successfully on the *Popillia* grubs, it is possible the *Tiphias* may develop a strain which will become parasitic on this introduced species.

NATURAL ENEMIES OF BEET LEAFHOPPER (*EUTETTIX TENELLA* BAKER)

By Henry H. P. Severin, Ph.D., *California Agricultural Experiment Station*

Abstract

Among the natural enemies of the beet leafhopper (*Eutettix tenella* Baker) are a large number of predaceous insects which prey upon the nymphs and adults. Seven species of egg parasites, two species of Pipunculus flies, a Dryinid and a hair-worm were bred by various entomologists in California. The percentage of parasitized

hoppers gradually increases during the summer months and reaches its height during August (35.1 per cent). The weak point in the parasitism of the leafhoppers occurs on the plains and foothills where 4.4 to 8.2 per cent were parasitized during the winter and 1 to 1.5 per cent during the spring.

I. Introduction

The importation of natural enemies to control introduced injurious insects in the United States and Insular possessions has been attempted with many pests. Although these imported parasites and predaceous insects assist in checking the multiplication and in certain years control the host, nevertheless, fluctuations in the abundance of the natural enemies and pest occur, so that parasitism can not be regarded as a dependable control year after year, except possibly in a few instances.

II. Sugar Cane Leafhopper Controlled by Natural Enemies

The best example generally known among sugar producers is the control of the cane leafhopper (*Perkinsiella saccharicida* Kirk.) by natural enemies in the Hawaiian Islands. After the accidental introduction of the sugar cane leafhopper, many natural enemies already present in Hawaii transferred their attacks to this pest, but it was not until after special importations of parasitic and predaceous insects that the hopper was brought under complete subjection. In the cane fields today, a large number of different enemies prey upon the nymphs and adults, such as spiders, earwigs, long-horned grasshoppers, preying Mantids, kissing-bugs, ladybird beetles, Pipunculus flies, Dryinids, predatory wasps and others. According to Muir (8), natural enemies control 90 per cent of the hoppers in the sugar cane fields.

Egg Parasites.—Among the imported natural enemies, egg parasites play an important role in the control of the cane leafhopper. It must not be assumed, however, that these egg parasites are the only factors in the control of the cane leafhopper. "When the hoppers increase to a serious extent through conditions unfavorable to the egg parasites, it is to the enemies of the nymphs and adults that we must look for a speedy reduction." Muir (8).

Local Outbreaks.—According to Muir (8), "every year there are a certain number of 'outbreaks' over limited areas. Most of these pass off without any appreciable damage to the cane, fully controlled by the parasites; a smaller number cause some damage before the parasites can control them, and a few do considerable damage."

III. Predaceous and Parasitic Enemies of Beet Leafhopper

According to Hartung (5) three predaceous bugs prey on the beet leafhopper in California: *Neides muticus* Say; *Zelus socius* Uhl.; and *Reduvicolus kalmii* Reut. Spiders were noticed by the writer feeding on the hoppers in the field. In the greenhouse control measures must be adopted against the Argentine ant (*Iridomyrmex humilis* Mayr.) which enter the cages, kill the nymphs and occasionally the adults, and carry them to their nests. In cages the green lacewing larva (*Chrysopa californica* Coq.) devours the leafhoppers. Specimens of *Geocoris pallens* Stal were frequently seen sucking out the juices of nymphs and adults. A reddish mite attached to the body of the beet leafhopper was sometimes observed.

Egg Parasites.—Hartung (5) bred three egg parasites from the egg of the beet leafhopper determined by A. A. Girault as follows: *Abella subflava* Girault; *Anaphes* sp. near *hercules;* and *Gonatocerus* sp. The last two egg parasites emerged from eggs of the beet leafhopper from Ravendale, Lassen County, California. Stahl (10) bred *Abella subflava* Girault at Riverside and calls attention to the fact that this was a primary egg parasite and not a hyper-parasite as Hartung (5) states. Stahl (10) reared two other egg parasites, *Polynema eutettixi* Girault and *Anagrus giraulti* Craw., at Spreckels and Riverside. The writer bred four egg parasites from the eggs of the beet leafhopper in the San Joaquin Valley as follows: *Polynema eutettixi* Girault; *Anagrus giraulti* Craw.; *Apelinoidea plutella* Girault; and *Anthemiella rex* Girault. These egg parasites were reared more abundantly from eggs deposited by the beet leafhopper in saltbushes (Atriplexes) than in sugar beets.

Parasites of Nymphs and Adults.—Two parasitic flies were bred from the beet leafhopper,—*Pipunculus vagabundus* Knab and *P. industrius* Knab. A wingless ant-like wasp (*Gonatopus contortulus* Patton) and the winged male were bred from the beet leafhopper. A parasitic hair-worm belonging to the Gordiaceae emerged and was also dissected on rare occasions from the beet leafhopper. A case of double parasitism by a hair-worm and a Pipunculus larva occurred in the abdomen of a single dark overwintering female collected on the foothills near King City in the Salinas Valley on November 28, 1918. The beet leafhopper was also parasitized by an occasional Stylops which was not bred.

The Pipunculus flies deposit an egg in the nymph or adult beet leafhopper. The egg hatches into a larva or maggot which feeds within the abdomen of the hopper. When the larva is full-grown it bores out

of the host, leaving a large exit hole usually at the junction of the metathorax and abdomen. The hopper is killed after the larva emerges. After escaping from its host, the larva buries itself beneath the soil and pupates. At Spreckels the flies issued after remaining in the pupal stage for a period of 22 days.

The female of *Gonatopus contortulus* is a wingless, ant-like parasite of the family Dryinidae. Mr. S. A. Rohwer determined "the two parasites bred from the beet leafhopper as *Gonatopus contortulus* Patton, and *Labeo* sp. n. He says that this male is no doubt that of the above female. There is much confusion about the males of Labeo, of which no female is known. Some male Labeo are males of females described in Gonatopus and Dryinus."

The ant-like female is a very active creature, capturing and partly devouring a large number of hoppers. A single parasite emerging in a cage will kill most of the leafhoppers, but it is only in an occasional leafhopper that an egg is deposited. The presence of the parasite in its later development can be determined by the external dark brown sac in the nymph or beneath one of the wings in the adult leafhopper. After the parasitic larva quits its host, it spins a white cocoon (length 3 mm. width 1.5 mm.) on the foliage of the saltbush or beet leaf. Forty days, after spinning its cocoon, the wingless parasite emerged on October 24, 1914 at Spreckels.

Percentage of Parasitism.—We (6) have published a paper on the natural enemies of the beet leafhopper and in 1913, about 3.2 per cent and in 1914, about 33.6 per cent of the leafhoppers collected in beet fields were found to be parasitized by *P. vagabundus*, *P. industrius* and *G. contortulus*.

During 1918–1920, a comparison was made of the percentage of parasitized beet leafhoppers collected on the plains and foothills with those captured in the cultivated areas of the San Joaquin Valley. Records obtained by dissecting the adults are more reliable than those secured by breeding the parasites, since a high mortality of the insects occurs in the breeding jars. The average percentage of parasitized adults of various broods by Pipunculus and Gonatopus is indicated in Table 1.

The weak point in the parasitism of the adults occurs on the plains and foothills. Dissections show that only those winter brood adults, which are parasitized by a tiny larva, fly to the foothills resulting in an extremely low percentage of parasitism of the spring brood. It is evident from Table 1, that the percentage of parasitism gradually

TABLE 1. PARASITISM OF BEET LEAFHOPPER ON PLAINS AND FOOTHILLS AND IN CULTIVATED AREAS OF SAN JOAQUIN VALLEY

Plains and foothills				Cultivated Areas			
Year	Months	Broods	Average percentage parasitism	Year	Months	Broods	Average percentage parasitism
1918–1919	Nov.–Mar.	winter	8.2	1918	Dec.	winter	28.0
1919	Apr.	spring	1.0	1919	Apr.–May	spring	3.5
				1919	June	summer	10.0
				1919	July	summer	22.3
				1919	Aug.	summer	35.1
				1919	Sept.	summer	32.0
					average	summer	25.5
1919–1920	Oct.-Feb.	winter	4.4				
1920	Apr.	spring	1.5				

increases during the summer months in the cultivated areas and reaches its height during August.

IV. Importation of Natural Enemies

In 1917–'18 Vosler (12) attempted the importation of natural enemies from Australia to California to control the beet leafhopper. One female Dryinid was imported and oviposited in the beet leafhopper confined in cages but no parasites were bred. The parasitism of this Dryinid of a leafhopper (*Eragrostis villosa*) in New South Wales was approximately 7 per cent. Two introduced egg parasites found "*E. tenella* an unsuitable host." In Victoria 85 to 90 per cent of the eggs of a leafhopper deposited in a saltbush (*Atriplex muelleri*) were parasitized by the two egg parasites.

Sugar company officials have frequently asked the writer as to the possibility of controlling the beet leafhopper through the importation of natural enemies. According to Ball (1) "*E. tenella* is a native insect inhabiting southwestern United States and northern Mexico, with an extension of area in the Columbia River region." The writer has taken large numbers of this insect on the Australian Saltbush (*Atriplex semibaccata*) at Mexicala, Mexico. Mr. E. P. Van Duzee (11) captured many specimens of *E. tenella* on islands in the Gulf of California as follows: "Isla Raza, April 21, abundant on Atriplex; Isla Raza, May 4, on Salicornia; Santa Inez Island, May 13, on Atriplex and Chenopodium, growing together rankly in masses; Ceralbo Island, June 7, on Sesuvium. Here they were larger and mostly pink in color, greatly resembling,

although distinct from, *rubicundulus* Van Duzee from Jamaica." Ceralbo Island is situated near the southeastern end of Lower California. Boncquet (2) found the beet leafhopper and curly leaf beets in the Argentine Republic, South America. The specimens of *E. tenella* were determined by Mr. E. P. Van Duzee and are in the collections of the California Academy of Sciences.

If the distribution of the beet leafhopper from Washington and Idaho south into Mexico represents the native home of this insect, then the natural enemies are not efficient agents of control. It is not to be assumed that all native insects are controlled by their parasites.

Entomologists probably would immediately come to the conclusion that the beet leafhopper was accidentally introduced into the Argentine Republic, but a careful consideration as to the possibilities that such has occurred is met with difficulties. If eggs deposited in weeds, or nymphs or adults have been transported in hay or straw from a beet leafhopper territory to the Argentine Republic, none of the three could survive in the dried vegetation. The possibility of introducing this insect in connection with the sugar beet and stock beet does not seem plausible. The only possibility that the writer can think of is, that eggs deposited in the foliage of garden or red beets or swiss chard taken from the breeding grounds of the leafhopper and transported in cold storage on steamers to be used as a vegetable dish or greens for the crew or passengers, may have hatched if taken ashore in the Argentine Republic. It is questionable, however, whether the eggs would survive in cold storage during a long trip around Cape Horn, possibly before the Panama Canal was completed. If the pest was accidentally introduced, it could have established itself easily on plants of the family Chenopodiaceae, to which the sugar beet belongs.

The distribution of insects is often limited by the geographical range of the native food plants. In all probability, the native host plants on which the summer and overwintering broods develop are representatives of the Chenopodiaceae. Dr. H. M. Hall (4), who has recently published a monograph on the Atriplex and other genera, has prepared for the writer a brief statement concerning the geographical distribution of the species of Atriplex and Chenopodium as follows:

Atriplex. There are numerous species throughout western North America as far south as tropical Mexico, the number of species as well as individuals diminishing towards the South. Too little is known of the botany of tropical America, but the genus is well represented in the West Indies, and occurs in Honduras and Venezuela. There are 2 or 3 species in Peru and Bolivia, more in Chile, and several in Argentine.

Chenopodium. *C. murale*, an introduced European weed, has been abundant

for a long time on the American continents. It is reported as almost continuous in its distribution, but it cannot now be verified for the tropics. *C. ambrosioides* is a native in warm temperate and tropical America and is now common from eastern Canada and California to Brazil and Argentine. It occurs only as an introduced species in the northern part of its range and perhaps in the extreme south in South America.

The present known distribution of the beet leafhopper corresponds with the geographical range of Red Stem Filaree (*Erodium cicutarium*), the most important winter host plant in which the dark overwintering adults deposit their eggs and on which the spring brood develops in California. According to Thornber (9) Red Stem Filaree now covers parts in Washington, Idaho, and Texas and the whole of Oregon, California, Nevada, Arizona, New Mexico and Utah. Hemsley (6) records Red Stem Filaree from "North Mexico, Monterey (Eaton and Edwards); South Mexico, Tacubaya (Bourgeau, 30), at the foot of the mountains of Orizaba (Schiede and Deppe), without localities (Hahn, Bates. etc.) Hb. Kew." Specimens of *E. cicutarium* are in the herbarium of the botanical department at the University of California collected by Dr. Nicolas Illin labeled as follows: "Flora Argentina, Terriorio del Chubut, 1903, No. 24."

Red Stem Filaree is supposed to have been originally introduced into America from the Mediterranean basin by the Spaniards although there is some difference of opinion among botanists. According to Brewer and Watson (3) *E. cicutarium* is "very common throughout the State, extending to British Columbia, New Mexico, and Mexico; also widely distributed in South America and the Eastern Continent. It has been generally considered an introduced species, but it is more decidedly and widely at home throughout the interior than any other introduced plant, and according to much testimony it was as common throughout California early in the present century as now." The possibility that the beet leafhopper was accidentally introduced in Red Stem Filaree from Europe is entirely out of consideration for if this plant was introduced into America from the Mediterranean basin it was through the seed carried in the wool of sheep.

A study should be undertaken as to the geographical distribution of the beet leafhopper for it does not seem possible that the range of this insect occurs from Washington and Idaho, south through the tropics into Argentine, South America. Dr. E. C. Van Dyke, an authority on the distribution of the Coleoptera, informed the writer that species of beetles are widely separated in the north and south temperate regions and that

there are but few native species of the United States which extend through the tropics into the south temperate zone.

If it is demonstrated that the leafhopper through migratory flights, has established itself in localities outside the range of its efficient parasites, then every effort should be made to introduce parasites into such natural breeding areas. Before any attempt is made to introduce natural enemies, a careful study should be undertaken of the habits of the parasites in their natural environment. If imported natural enemies were liberated on the plains and foothills of a natural breeding ground in California, and a spring dispersal of the parasites did not occur, they certainly would not survive after the pasture vegetation becomes dry. The habits of the parasites would require careful study in their native habitat to determine whether they would winter over in the cultivated regions or whether autumn dispersal and hibernation occur on the plains and foothills. Parasites should not be introduced into the migratory breeding districts of the leafhopper for it is a well known fact that when insects migrate from their natural breeding areas, they fail to establish themselves in their new environment unless they meet conditions identical with their original habitat. Preliminary experiments should be conducted with the egg parasites already attacking the eggs of the beet leafhopper in California to determine the proper methods of breeding them. There are many other factors to be taken into consideration in the importation of natural enemies, such as the question of general or specific primary parasites, secondary parasites, and environmental factors, which need no further discussion.

V. Acknowledgments

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TEMPERATURE AS A LIMITING FACTOR IN THE LIFE OF SUBCORTICAL INSECTS

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ABSTRACT

The distribution of insect species within a log depends to a very large degree upon the temperature in different parts of the log. The most heat resistant groups, of which the genus Chrysobothris is representative, are found only in the warmer parts, whereas those species less resistant to heat are found only where extremely high temperatures do not occur. On the basis of temperature it is possible to divide the insect inhabitants of a log into several ecological groups.

The importance of temperature as a limiting factor in the life and distribution of insects in general has long been recognized by biologists. In most of our discussions of the effect of temperature upon the distribution of terrestrial organisms we have thought most frequently in terms of large areas, but now we are beginning to realize the importance of this factor in limited environments. We now know that steep temperature gradients occur in very short periods of time or within very short distances. This explains many of the puzzling instances of periodicity and peculiarities of local distribution among certain insects.

The effect of temperature upon the distribution of insects in a small

environment is well illustrated by the insect life in logs, particularly by those insects that live just beneath the bark. The present paper is based upon a series of experiments carried on in Itasca Park, Minnesota, at the University of Minnesota Forestry School and Experiment Station. These experiments have extended over a period of four years, during which time considerable data concerning the effect of physical factors of the environment upon insects attacking logs have been accumulated.

For the purpose of this article it seems desirable, for the sake of simplicity, to select for discussion only a few insects, representing several ecological groups. The insects included in the experiments just mentioned that seem to best satisfy our requirements are as follows:

1. *Ips pini* Say
2. *Monochamus scutellatus* Say
3. *Chrysobothris dentipes* Germar

These species are very abundant and reacted very definitely to temperature conditions.

The Effect of High Temperatures

Before we can interpret field observations correctly we must usually have as a basis laboratory experiments. This study of temperature effects is no exception, and a knowledge of temperatures fatal to those insects that we are considering is essential. As all of the observations upon which this paper is based were made during the summer season, the effect of extremely low temperatures is not considered.

Table I illustrates the effect of high temperatures upon the adults and larvae of these three species.

Table 1. Fatal High Temperatures in °C

Species	Stage	Minimum death temperature	Average death temperature	Maximum death temperature
Monochamus scutellatus	Adult	43	47	50
	Larvae	45	48	50
Ips pini.	Adult	44	48	50
	Larvae	44	46	49
Chrysobothris dentipes. .	Adult	45	50	52
	Larvae	—	—	

These figures show a considerable individual variation in death temperature in both the adult and larval stages. Cases must frequently occur in nature where an entire brood would be destroyed if it were not for some of those exceptional individuals that fall without the

average. It would appear that if it were not for these erratic individuals, adaptation of a species to new or changed environmental conditions would be difficult if not impossible.

Subcortical Temperature Conditions

Most of us think of bark as an excellent insulating material, and from this idea the assumption arises that a log may be regarded as a buffer medium and that the forms of life beneath the bark are protected to a large degree from sudden temperature changes and from extremes of temperature. The insulating power of bark is not so great as we usually suppose. The work of Craighead (1920) calls the attention of entomologists to the high temperatures that occur under the bark of logs lying in the sun. He points out that solar radiation may raise the subcortical temperature above a point fatal to the insect inhabitants of the logs. The author (1920) has shown that the chief factors influencing subcortical temperatures may be summarized as follows:

1. Solar radiation
   a. Light intensity
   b. Solar altitude
   c. Angle of incidence
2. Character of bark
   a. Color
   b. Surface
   c. Structure
   d. Thickness
3. Air temperature
4. Air movement
5. Evaporation from bark surface
6. Proximity to other radiating or absorbing surfaces

The highest temperatures recorded in these experiments were observed beneath the dark colored bark of white pine. Color of the bark determines to a very considerable degree the amount of solar heat absorbed by the bark surface. Thus, other things being equal, the darker the bark the higher the subcortical temperature. Frequently the noon temperature exceeded a point fatal to most insects and several times exceeded 60° C. Table II, shows the subcortical temperatures that were observed at noon under various shade conditions. The influence of character and thickness of the bark is illustrated in Table III.

TABLE II. NOONDAY SUMMER SUBCORTICAL TEMPERATURES IN WHITE PINE LOGS IN °C[1]

Degrees of shade	Maximum	Minimum	Average
0	65.0	17.5	45.6
1/3	54.0	15.5	36.5
1/2	48.0	14.0	34.4
3/4	39.0	14.0	27.7
Complete	28.0	11.0	18.4

TABLE III. INFLUENCE OF BARK CHARACTER UPON SUBCORTICAL NOONDAY TEMPERATURE IN °C

	Bark				
Species	Character	Thickness	Maximum	Minimum	Average
White pine	Rough	13 mm	47.0	18.0	35.1
White pine	Rough	12 mm	48.0	17.0	36.4
White pine	Smooth	5 mm	53.0	17.0	40.6
Norway pine	Scaly	13 mm	45.0	18.0	32.7
Norway pine	Scaly	5 mm	45.0	17.0	32.8
Norway pine	Scaly	1.5 mm	46.0	17.0	33.8

This table shows that in white pine the thickness of the bark is an important factor determining the subcortical temperature, whereas in Norway pine the scaly character of the bark appears to be the more important. From this it naturally follows that there would be differences in subcortical temperature between different species. The next table illustrates this point more fully.

TABLE IV. VARIATIONS IN NOONDAY SUBCORTICAL TEMPERATURES BETWEEN LOGS OF DIFFERENT SPECIES IN °C[1]

	Bark				
Species	Character	Thickness	Maximum	Minimum	Average
White pine	Smooth	5 mm	55.0	17.0	40.0
Jack pine	Scaly	4 mm	51.0	17.0	38.0
Spruce	Scaly	2 mm	49.0	17.0	36.0
Norway pine	Scaly	5 mm	45.0	17.0	32.0

From these data it is obvious that a wide range of temperature may occur between logs of different species, between logs of the same species differing in color, character, thickness of the bark, and between similar logs under different conditions of shade. These facts, combined with our knowledge of the temperatures fatal to insects makes it possible to prophesy with a reasonable degree of accuracy where the insects under consideration in this paper would be found in nature. We should not expect to find *Monochamus scutellatus* living and developing on the

[1]Logs lying in a north and south direction, with north end slightly elevated. These figures are based upon data collected over four seasons.

upper side of white pine logs exposed to full sunlight except in the case of a few very thick barked logs. On the other hand, *Chrysobothris dentipes* with its much higher fatal temperature would find conditions satisfactory for its development on the upper side of many logs lying in the sun. We might also expect to find that the cooling effect of dense shade, although it might not be in itself fatal, would so reduce the rate of development of the insect inhabitants of logs placed in such situations that higher mortality than normal of the insects within the logs would result. That these theoretical deductions are in general correct is shown in Table V. In this table the actual distribution of these three species is illustrated.

TABLE V. DISTRIBUTION OF SUBCORTICAL INSECTS UNDER DIFFERENT CONDITIONS[1]

	Top side Degree of shade					West side Degree of shade				
Species	0	1/3	1/2	3/4	Full	0	1/3	1/2	3/4	Full
					Ips pini Say					
White pine....	1.1	40.2	77.1	131.4	42.1	67.4	56.1	98.8	91.8	50.0
Jack pine.....	0.4	9.2	33.5	64.4	21.6	21.7	36.1	43.7	33.6	23.5
Norway pine..	73.4	69.4	164.2	125.9	41.5	86.5	60.0	99.0	84.4	37.5
					Monochamus scutellatus					
White pine....	0.5	2.0	5.2	2.2		6.7	7.0	10.5	6.0	
Jack pine.....	1.6	0	1.3	0.6		2.6	4.3	1.3	2.0	
Norway pine..	1.0	1.0	0.6	1.0		4.0	2.0	3.0	3.0	
					Chrysobothris dentipes					
White pine....	19.7	17.2	2.5	0	0	2.7	0.2	0	0	0
Jack pine.....	17.0	5.0	0.6	0	0	0	0	0	0	0
Norway pine..	12.0	1.0	0.3	0	0	0	0	0	0	0

	East side Degree of shade					Bottom side Degree of shade				
	0	1/3	1/2	3/4	Full	0	1/3	1/2	3/4	Full
					Ips pini Say					
White pine....	69.9	74.9	90.5	64.0	39.3	23.3	21.2	23.1	23.2	38.5
Jack pine.....	39.7	48.0	63.1	33.9	27.0	17.4	19.3	12.5	14.7	19.6
Norway pine..	80.6	59.3	95.1	81.5	42.1	40.0	16.5	31.4	35.8	44.1
					Monochamus scutellatus					
White pine....	5.2	4.5	11.2	4.5		5.5	4.2	11.6	2.2	
Jack pine.....	1.3	4.0	1.3	0.3		3.0	2.3	2.3	1.0	
Norway pine..	1.3	1.6	4.3	1.3		4.6	3.3	1.3	2.0	
					Chrysobothris dentipes					
White pine....	4.0	2.5	0	0	0	0	0	0	0	0
Jack pine.....	3.0	0.6	0	0	0	0	0	0	0	0
Norway pine..	0.3	0	0	0	0	0	0	0	0	0

[1]Data presented in this table represents the number of insects present per unit area of one square foot.

The actual distribution of these three species as illustrated in this table is approximately what would be theoretically expected. On the upper side of jack pine and white pine, where very high temperatures occur, *Ips pini* and Monochamus are almost never found, whereas the sun loving species, *Chrysobothris dentipes* with its comparatively high fatal temperature finds such a location to its liking. In the Norway pine where lower temperatures maintain, we find an increased number of *Ips pini* and a decreased number of *Chrysobothris dentipes* in the warmest locations. On the lower side and under heavy shade there is a decided falling off in the abundance of all three species.

Conclusions

The three species considered in this paper show very definite temperature reactions and temperature doubtless plays an important role in the life of all of them. Temperature determines their rate of development, their distribution, and in many cases the per cent of their mortality. These experiments have shown such a variation in abundance of the same insect under different environmental conditions that the prospect of checking the development of insects in logs by controlling storage conditions is encouraging.

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A METHOD FOR THE EXTERMINATION OF THE ROUND-HEADED APPLE-TREE BORER

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ABSTRACT

As a substitute for the "digging-out" process, fumigation with carbon disulphid proved very successful. Against the tree, with the open side over the borer holes, a cell with open top, resembling a large mud wasp's nest, is built of plastic clay or mud. A teaspoonful of carbon disulphid is poured in and the cell closed with a plug of clay. The surface of the cell is then wetted and smoothed down, and carefully sealed to the tree and the earth. This method gives 100% control when properly done, requires less time than the "digging-out" process, and neither mutilates nor injures the tree.

In my little orchard, the past year, nearly all of the apple trees, about 40 in number, were badly infested with the round-headed borer. After some desultory work, attempting to dig out the larvae with a knife, I began the use of carbon disulphid. The results were so satisfactory that I will describe the procedure in some detail.

Slingerland and Crosby (Manual of Fruit Insects, page 192) say "Other kinds of borers in shade or park trees have been successfully treated by injecting a little carbon disulphid into the small hole from which the sawdust-like excrement is being pushed out, and the hole quickly plugged with putty or grafting wax. The deadly fumes of this very volatile liquid penetrate the burrow and finally kill the borers. Orchardists should give this sensible method a thorough trial. A similar treatment has been successfully used by some fruit-growers."

This method, while advantageous where the hole of the burrow is clear-cut, cannot well be applied in cases where there are a number of holes leading into communicating burrows, or where the holes are in part below the sod. Treatment by the method to be described was begun late in July, and continued, as more infested trees were discovered, until into September.

The following recommendations, if carefully observed, will completely control this apple-tree pest.

1. Clear away water sprouts, grass, and sod from around the base of the tree for a distance of 6 inches. This is good orchard practice in any case. Rough bark and borer-frass should also be brushed away. As the holes in some cases are found below the surface it is well to scratch the soil away from the base of the tree to the depth of about an inch.

2. After one or more days, the trees should be examined for indications of renewed activity of the borers to be sure that time is not wasted on a tree from which the borers have already departed. In some cases, especially late in the season, some weeks may elapse before more frass is thrown out after the tree has been cleared at the base.

3. Mix some fine, homogeneous clay with a little water, until it is perfectly smooth and has the consistency of putty or plasticine. Probably any fine soil will answer provided it is free from stones and sticks, and not crumbly. If the clay is from the surface and very dry it will facilitate matters to let it stand for several hours with a little water poured over it. A pail full of this plastic material is enough for five to ten trees. With increased experience a smaller amount of clay may be used per tree than at first.

4. Wet the soil at the base of the tree. If the soil is porous, work a

little clay into it. Against the tree, with the open side over the borer holes, build a clay cell with open top, resembling a large mud-wasp's nest. Have ready a flat piece of clay for a lid. The size of the cell is dependent upon the number of holes it has to cover.

5. Put a small, loose wad of paper in the cavity of the clay cell, pour over it a teaspoonful of carbon disulphid, and clap on the lid.

6. Quickly and firmly seal on the lid, wetting the surface of the whole cell, rubbing smooth with the hand, and sealing tightly to the ground and to the tree. If the clay or muck is of the right sort, an air tight cell is thus formed which communicates only with the burrows of the borers. If the clay cell is well constructed, the odor of the carbon disulphid is still apparent upon opening the cell 24 hours later. Upon investigation the insect will be found dead in its burrow. In my experiments I did not fail to kill the boreres *in situ* in a single instance.

A few cautions should be observed. Use fine clay or loam such as will work up well into a putty-like mass and is not crumbly. Seal the cell carefully to the tree and to the ground, smoothing the surface with the hand which has been dipped in water. If the ground is porous, floor the cell with clay also. Follow up your work after several weeks. Some of the borers may not have been active when going over the orchard the first time and thus have been overlooked. Mark the side of the tree which has been treated so that later on you may know how effective your work has been.

This method kills borers in the root-base as well as those in the trunk. A man working alone should be able to treat 50 trees a day effectively, which is more than can be done by the digging-out process, as figures, which have been kept by the Department of Pomology of Cornell University, show. The method is applicable to trees of any size and for borers of any age. It may be used at any time between May and October. It has the advantage over "digging out" in that it requires less time, neither mutilates nor injures the tree, and when properly done is 100% efficient.

Instead of clay, plasticine may be used. It is easy to apply, takes less time, is much less messy, and may be used several times over. The only objection to it is the expense. Whether the slight amount of oil in its composition has any injurious effect upon the tree remains to be seen. Dry, finely pulverized clay mixed with about one-fifth its bulk of vaseline makes a fair substitute for plasticine.

In a few cases where the borer holes were up some distance from the base, tar paper was used for the body of the cell and sealed to the tree

with clay. No time was saved however by the use of the paper. A pound of carbon disulphid at a cost, say of 40 cents, is sufficient for treating 75 to 100 trees. It is needless to add that the liquid is volatile, explosive in the presence of a flame, and poisonous, so care should be taken in handling it.

LUBRICATING-OIL EMULSION AS A CONTROL FOR *CHRYSOMPHALUS AONIDUM* IN GREENHOUSES

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Abstract

The need for a more efficient contact insecticide for hardy ornamentals in greenhouses suggested the desirability of testing lubricating oil emulsion which had proved so effective for white flies in Florida, and recently against San Jose scale. In 1922 young Kentia palms, heavily infested with the Florida red scale, *Chrysomphalus aonidum* L., were sprayed one, two, and three times in succession with 1:50 (or 1-1/3%) "Boiled," and "Cold-stirred" emulsions. Formulas for each are given and appeared equally effective. In 1923 a miscellaneous group of infested plants, including Kentia, Phoenix, Aspidistra, Ficus, Laurus nobilis, Aucuba Japonica, and citrus sp. were sprayed with "Boiled" emulsion. The 1:32 and 1:25 dilutions left the foliage greasy and yellowed the palm fronds. Spraying once with the 1-1/3 % emulsion if thoroughly done gave a satisfactory control without injury to the plants. Results of experiments are presented in the table.

During the past ten years lubricating-oil emulsion has been used extensively in Florida for the control of white flies and scale insects in citrus orchards. More recently it has proved very satisfactory as a dormant spray for the control of San Jose scale in apple orchards in the Ozark region of Arkansas and Missouri.

The remarkable insecticidal efficiency obtained from a 2% emulsion, and the fact that it contained very little oil suggested the possibility of using this material on ornamental greenhouse plants infested with scale insects, because the margin of safety in the use of insecticides under glass is narrower than out of doors. The development of a contact insecticide having such qualities would meet a constant demand on the part of greenhouse men for a remedy which would be more effective against scale insects than nicotine soap solutions or other contact sprays and would be suitable for treating palms, Ficus and other hardy plants. Moreover, it could be used where circumstances would not permit fumigation with hydrocyanic-acid gas.

During the summer of 1922 a number of young Kentia palms heavily infested with the Florida red scale, *Chrysomphalus aonidum* Linn., were available for such a test. Preliminary experiments were undertaken to

determine whether this insecticide could be used safely at a strength which would kill the insects. Both the "boiled" and "cold-stirred" emulsions were prepared according to the following formulae[1] using Junior Red Engine Oil and potash fish-oil soap as ingredients.

Boiled Emulsion Formula		Cold-stirred Emulsion Formula	
Paraffin oil	gallons 2.	Paraffin oil	gallons 2.
Water	gallons 1.	Water	gallons 1.
Fish-oil soap	pounds 2.	Fish-oil soap	pounds 8.

In each case these stock emulsions were then diluted 1:50 (or 1–⅓ per cent), and applied to the infested plants by means of a one-gallon compressed-air sprayer. Some of these plants were sprayed two or three times in succession at short intervals in order to determine the relative efficiency of such treatment.

The results of the 1922 experiments, 1 to 10 inclusive which are presented in Table I indicate that the "boiled" and "cold-stirred" emulsions were about equally effective in controlling this scale insect. Moreover, differences in time intervals between successive applications produced no outstanding variation in control. The equated percentages of control are not included because the per cent normally dead in the composite check for the same period, viz, 5.9 per cent as shown in Experiment 11, was too low to reduce the control results materially. Experiments 1 and 6 represent the probable degree of control resulting from one application of the emulsion. The lower per cent of control obtained from similar treatments in Experiments 2 and 7 is explained by the fact that some of the observations were made before sufficient time had elapsed to allow all scales affected by the treatment to succumb. Two treatments at intervals of 11 and 26 days respectively as shown in experiments 3 and 8, and 4 and 9, gave very good control. Three treatments with intervals of 11 and 15 days between successive applications gave 100% control in Experiments in 5 and 10.

These preliminary tests gave such convincing evidence of the insecticidal action of the emulsions that it was deemed desirable to establish the usefulness of the "boiled" emulsion by further experiments under normal growing conditions. Such tests would not only furnish additional proof of its insecticidal efficiency but also throw more light on its effect on the plants.

Fortunately in 1923 a rather heavy infestation of Florida red scale, which was discovered in a house of palms at the Botanic Gardens, was

[1]Yothers, W. W. "Spraying for the control of insects and mites attacking citrus trees in Florida." U. S. Dept. Agr. Farmers' Bul. 933.

TABLE 1.—EFFECTIVENESS OF SUCCESSIVE SPRAYING WITH LUBRICATING-OIL EMULSIONS (1:50) FOR CONTROL OF CHRYSOMPHALUS AONIDUM LINN.

Number of experiment	Type of emulsion	Number of applications	Date of applications	Total period of observation	Condition after spraying dead	Condition after spraying alive	Percent control	Host	Remarks
			1922	Days					
1	Boiled	1	July 12	43	915	65	93.3	Kentia sp.	
2	do	1	Aug. 3	25	429	254	62.8	do	Some examined August 10
3	do	2	Aug. 3, 14	25	178	0	100.	do	
4	do	2	Aug. 3, 29	50	564	10	98.2	do	
5	do	3	Aug. 3, 14, 29	50	521	0	100.	do	
6	Cold-stirred	1	July 12	43	448	36	92.5	do	
7	do	1	Aug. 3	25	391	175	69.0	do	Some examined August 10
8	do	2	Aug. 3, 14	25	196	13	93.7	do	
9	do	2	Aug. 3, 29	50	323	3	99.0	do	
10	do	3	Aug. 3, 14, 29	50	780	0	100.	do	Normally dead
11	Check	0	July 24 to Sept. 12	50	273	4357	5.9	do	
			1923						
12	Boiled	1	June 14	27	151	0	100.	Kentia sp.	
13	do	1	June 14	19	325	5	98.4	Aspidistra lurida	
14	do	1	June 14	19	205	0	100.	Laurus nobilis	
15	do	1	June 14	19	335	3	99.1	Phoenix rupicola	
16	do	2	Aug. 3, 29	64	125	6	95.4	Kentia sp.	
17	do	2	Aug. 3, 29	52	1800	148	92.5	Aspidistra lurida	Live scales in folded leaf
18	do	2	Aug. 3, 29	63	375	19	94.9	Citrus sp.	Live scales on smooth upper surface of leaf
19	do	2	Aug. 3, 29	64	190	0	100.	Ficus elastica	

placed at our disposal to conduct these investigations. In addition to Kentia palms this house also contained such ornamental plants as *Phoenix rupicola*, *Aspidistra lurida*, *Ficus elastica*, *Laurus nobilis*, *Aucuba Japonica*, and *Citrus* sp., all of which were infested.

For the purpose of determining the possibility of increased control and the probable limits of plant tolerance, several plants were sprayed with a more concentrated emulsion. A single treatment with either a 1:32 or a 1:25 "boiled" emulsion killed 100% of the scale insects, but unfortunately it also impaired the ornamental value of the foliage by leaving it greasy, and, in the case of palms, causing the fronds to turn yellow.

To verify previous work with the 1:50 "boiled" emulsion, a miscellaneous group of plants growing in the palm house under normal greenhouse conditions was sprayed once, on June 14, using a 24-gallon Deming Sprayer equipped with a disk nozzle. From the results of experiments 12 to 15 inclusive, it is quite evident that very satisfactory control can be obtained from *one* application of this insecticide. In view of the fact that no injury had developed on these plants within seven weeks after treatment, the remainder of the plants was then sprayed twice in succession, viz, August 3 and 29 with a 1:50 boiled emulsion.

Final observations on the effects of two applications of the "boiled" emulsion are given in the table under experiments 16 to 19. In this connection it should be noted that scales found alive had apparently escaped contact with the insecticide even after two treatments. For example, most of the living scales listed in experiment 17 occurred in a group within a folded section of Aspidistra leaf. Also in experiment 18 live scales were found only on the smooth upper surface of a citrus leaf to which the emulsion had apparently failed to adhere. The plants have shown no evidence of injury from these treatments.

Assuming that two or three treatments at close intervals would insure complete control, it is doubtful whether the difference in effectiveness would be sufficient to justify the additional expense of application and the greater risk of injury. The results of these investigations demonstrate that spraying *once* with a 1:50 "boiled" lubricating-oil emulsion, provided it is thoroughly done, will give a very satisfactory control of the Florida red scale, *Chrysomphalus aonidum* Linn. without injury to hardy ornamental greenhouse plants.

A STILT-BUG, *JALYSUS SPINOSUS* SAY, DESTRUCTIVE TO THE TOMATO

By C. R. Phipps, *Mountain Grove, Mo.*

Abstract

A stilt-bug, *Jalysus spinosus* Say is recorded as a serious pest of the tomato in Missouri. It is distributed from Maine to the Rocky Mountains and commonly occurs on the undergrowth of oak woods. It causes the blossoms to wither up and drop off, preventing the plants from setting fruit. The life-cycle, appearance, nature of injury, and control measures are briefly discussed.

This insect was first recorded as an enemy of the tomato in Missouri, several years ago. Its depredations have apparently not been as severe or its work may have been attributed to other agencies during the past few seasons, for no further record of its injury appears. During the past summer, however, the writer's attention was directed to it again, by an apparent blighting of the tomato blossoms in and around Mountain Grove and in other parts of the state. There was a consequent failure in the set of fruit and upon examination, early in July, it was found that there were many stilt-bugs present and that these insects were responsible for the damage done.

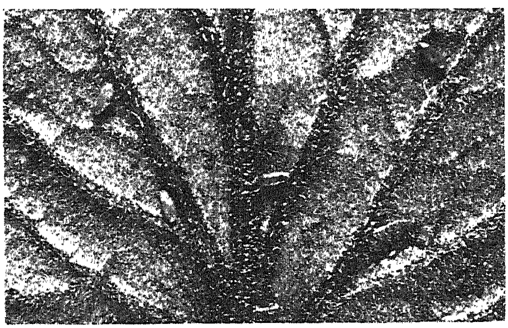
Description

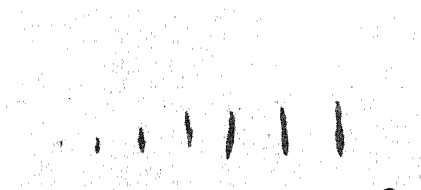
Jalysus spinosus (Say) belongs to the family Neididae, order Heteroptera. The adult is a brown stilt-bug whose body, legs and antennae are very long and slender. The antennae are as long as the body, four-jointed, distinctly elbowed, have the tip of the first joint enlarged, and are clubbed at the ends. The beak is four-jointed with normal basal segment; head with a transverse incision before the ocelli. This species may be distinguished from others in the genus by the absence of spines on the vertex, and by the presence of an inclined rather than a decurved scutellar spine. The males are shorter and more slender than the females and average about 7 mm. in length. The latter average from 8 to 9 mm. in length.

The eggs are pale yellow or nearly white in color when first deposited and are about 1 mm. in length. They are cylindrical in shape and have convex, rounded ends as shown in Pl. 4, Fig. 2. They soon become much darker, varying from deep yellow to nearly brown just before hatching.

The newly hatched nymphs are about 1 mm. in length and are yellowish brown in color. The legs, antennae, and beak are darker, however. The body color becomes light green in the second instar, but the legs, antennae and beak undergo no change. There is no marked color change during the three remaining instars.

1.





3.

1.—Injury to blossom cluster.
2.—Eggs on tomato leaf (enlarged about 7 times).
3.—Nymphal stages and adult male and female.

Distribution and Food Plants

Jalysus spinosus Say formerly belonged to the Berytidae and has been referred to by Howard, Comstock and other writers in discussing that family. The insect has a wide distribution, having been recorded from New England to the Rocky Mountains. It is often found in the undergrowth of oak woods, according to Howard. This doubtless accounts for its abundance in the post oak sections of Missouri. It has been recorded as feeding on sumac, hazel, peach, corn, tomato, horse nettle, and several members of the Onagraceae or Evening Primrose family. The writer has noted it feeding on the eggplant as well as on corn and tomato in the garden, but has never been able to find eggs upon the former. During 1914 Somes recorded it from all parts of Missouri and as far north as Sioux City, Iowa.

Nature of Injury

The nymphs and adults of this species feed on the juices of the tomato and other plants. They injure the tomato by inserting their beaks in the stems, blossom buds, and fruit itself. (Pl. 4, Fig. 1) The principal injury results from the blossom and fruit stem punctures which cause the blossoms to wither up and drop off, or at any rate to fail to set fruit. Altho the insects are rather sluggish, the adults fly readily when disturbed and may be a factor in the spread of southern blight and other tomato diseases.

Life History

Since the insect failed to attract attention until about the middle of July, this season, the writer was unable to follow its entire life-cycle. The adults winter over under leaves and rubbish of various sorts, emerge in the spring and feed upon wild host plants until the more attractive truck crops are growing in the fields. The first generation of nymphs is probably passed on these wild hosts, the resulting adults migrating to the cultivated plants in June or early July. There are two complete broods and a partial third, on the tomato, according to our observations this season. Many nymphs of the third brood, on the tomato, failed to reach maturity owing to freezing weather early in November. Oviposition occurred abundantly on the tomato the latter part of July and again a little over a month later. The eggs are deposited, singly, on the upper and lower surfaces of the leaves, on the stems, and on the blossoms. Females in confinement averaged from 7 to 10 eggs each. These

eggs were laid over a period of from 1 to 4 days. Under field conditions the number of eggs per female would probably be greater. The majority of the eggs hatched in about three days. The average length of time from the egg to the adult stage was about 35 days. Table 1 shows the seasonal history of the insect. The writer began the study too late in the season to observe the early feeding on the wild plants and that part of the table is approximated.

TABLE 1. SEASONAL HISTORY OF *Jalysus spinosus* SAY AT MOUNTAIN GROVE, MO., 1923

Life Cycle	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.
Hibernating Adults......	- - ∘	∘ ∘ ∘	∘ ∘ ∘	∘				
First Generation....		Nymphs	∘ ∘ Adults	∘ ∘ ∘ * *	* * *			
Second Generation....				Nymphs	* * * Adults	* * * * * * *	* * *	
Third Generation....					Nymphs	* * Adults	* * * * * *	* * - -
Fourth (Partial)....						Nymphs	* * Adults	* * - -

Table II gives the length of the various stages as observed during the past season.

TABLE II. LENGTH OF DEVELOPMENTAL STAGES AT MOUNTAIN GROVE, MO.

Stage	No. Days	Average No. Days
Egg	3–6	4.0
Ist Instar	3–10	6.5
2d "	3–11	5.0
3d "	2–10	5.6
4th "	4–8	6.0
5th "	6–10	7.2
	21–55 Averages	34.3

CONTROL MEASURES

Thoro applications of nicotine sulfate and Bordeaux mixture are effective in killing the nymphs and protecting the foliage from subsequent attack by adults. Two applications, the first as soon as migration to the tomato is noticed, and the second early in August when the majority of the first brood nymphs are present, should give effective control.

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CERTAIN WILD GRASSES IN RELATION TO INJURY TO CORN BY THE "BORER" (*DIATRAEA SACCHARALIS* FAB.) IN LOUISIANA

By THOS. H. JONES and W. G. BRADLEY, *Louisiana Agricultural Experiment Stations*

ABSTRACT

Corn grown in Louisiana is often severely injured by the "sugar-cane moth-borer," *Diatraea saccharalis* Fab. Ten stalks in a very heavily infested field gave an average of 46.2 larvae, pupae, and pupal cases to the stalk. Larvae have been found, especially during the fall and winter, in several wild grasses. Some of these grasses grow abundantly in areas where the borer causes so much damage to corn. It seems certain that severe injury to the corn is due to moths that fly to it upon issuing from these grasses in the spring.

During recent years there has been much complaint of injury to corn in Louisiana by the "sugar-cane moth-borer" (*Diatraea saccharalis* Fab.). Not having available any definite records concerning the amount of damage caused by the pest during the past it is not possible to say whether it is becoming more abundant, but in certain sections it would appear that injury to corn has been more noticeable of late. Judging by inquiries received at the Louisiana Experiment Stations this appears true, for instance, in the Parishes of East and West Feliciana and East Baton Rouge. The degree of damage to corn by the borer varies greatly. In some instances it is so serious that no crop of ear corn is made, but this is not usual. Commonly, however, many injured stalks break over; being so weakened that they are unable to stand even light winds. Injury to the shank, the cob, the kernels, and the shuck is also important, particularly since it often results in subsequent decay and offers opportunity for secondary injury by certain other insects.

As to how abundant the borer may become in corn the following figures are of interest. On September 5, 1923, ten stalks were cut at random from a small planting of late corn at Baton Rouge in which the silk on the majority of ears had turned brown. It was apparent, from a superficial examination, that the corn in this field was very heavily infested and later observation showed that, because of borer injury, no ears matured. Counts were made of the larvae, pupae, and pupal cases

found in the ten stalks. In all 254 larvae, 139 pupae, and 69 pupal cases were found; an average of 46.2 larvae, pupae, and pupal cases in each stalk.

In connection with *Diatraea saccharalis* we have recently spent some time in attempting to ascertain the importance of its wild food-plants in those sections where there has been so much complaint of injury to corn during the past few years. It was thought that the abundant growth of various grasses in these areas had some bearing on the abundance of the borer in corn. While the question of wild food-plants has been given some consideration by other investigators it was believed that it was well worth further study in these particular areas. Collections of larvae feeding in the stems of various grasses have been made and Dr. H. G. Dyar of the U. S. Bureau of Entomology has kindly identified the moths that have issued. Adults of *Diatraea saccharalis* have been reared from larvae taken from the stems of the following grasses:—*Panicum barbinode*, *Paspalum larrañagae*, *Panicum gymnocarpon*, *Panicum dichotomiflorum*, *Holcus halepensis*, and *Andropogon glomeratus*. The first two species were determined by Miss Agnes Chase of the U. S. Bureau of Plant Industry and the others by Dr. C. W. Edgerton of the Louisiana Experiment Stations. Some of these grasses do not appear to have been heretofore recorded as food-plants of *Diatraea saccharalis*.

Larvae were common in the stems of a small patch of Para grass, *Panicum barbinode*, at Baton Rouge on October 11, 1922; 25 being taken by one collector in 40 minutes. They were found in the stems of the same patch of grass when examinations were made on November 24, 1922, and on January 13 and March 24, 1923, but by the latter date had become scarce and only 2 larvae and 2 pupae were found in 40 minutes. Pupae were found on January 13 and the finding of empty pupal cases on March 24 indicated that moths had issued during the winter. The winter was mild and the grass remained green until frosted in early February. While we are not positive that all the larvae and pupae observed in this patch of grass were of *Diatraea saccharalis*, there seems little doubt of this, since all of 35 moths reared from larvae and pupae collected on the above mentioned dates have been identified by Doctor Dyar as belonging to this species.

Larvae of *Diatraea saccharalis* were common in patches of *Panicum gymnocarpon* and *Panicum dichotomiflorum* at Baton Rouge during October, 1922, and were taken from Johnson grass, *Holcus halepensis*, on November 8. From collections of larvae taken from stalks of broom

sedge, *Andropogon glomeratus* and *Andropogon virginicus*, at Baton Rouge during the winter only one adult of *Diatraea saccharalis* issued, while 35 moths of *Platytes densellus* Zell. were obtained. *Diatraea saccharalis* and *Diatraea evanescens* Dyar were found infesting stems of *Paspalum larrañagae* at Elm Park, La., during the summer of 1923.

As regards the occurrence of *Diatraea saccharalis* in rice it is of interest to note that from larvae collected from stems of volunteer rice at Baton Rouge on Janurary 3, 1923, 16 adults were obtained, whereas only one moth of the so-called "rice stalk-borer," *Chilo plejadellus* Zinck., issued.

From larvae of *Diatraea saccharalis* collected from grasses in January, 1923, and placed in outdoor cages at Baton Rouge 42 moths issued. The first appeared on March 22 and the last on May 16. From larvae collected during October and November, 1922, and March, 1923, and placed with food in jars in a well ventilated insectary, 21 moths developed. The first issued on April 7 and the last on May 17. There appeared to be no day or succession of days when the moths issued in greatest numbers. From 3 pupae taken in the field on January 13, 1923, moths issued in the insectary on January 20, January 31, and February 13.

Some of the grasses in which *Diatraea saccharalis* has been found to breed grow abundantly in areas where the borer has caused so much damage to corn in the past few years. It seems certain that, in the summer, after the corn becomes dry and loses its attractiveness for the borer, the moths fly to certain large-stemmed grasses and there deposit eggs and in the Spring moths that issue from grasses fly to the attractive young corn and lay eggs thereon. We should, therefore, expect a decrease in infestation by the borer in corn if the grass areas in which the pest passes the winter were eliminated or the stages present in these grasses destroyed during the winter, although more definite information, especially on the flight of the moth, should be obtained before recommending such practice as a method of control.

In Bulletin No. 746 of the U. S. Department of Agriculture Messrs. Holloway and Loftin state, with respect to *Diatraea saccharalis* as a pest of sugar cane, that "the number of food plants, some of which grow wild about plantations, makes the species more difficult to control than if it were limited to corn and sugar cane, the larvae being able to grow to maturity on wild grasses and the adults migrating to the corn and cane fields." Our observations indicate that the question of wild grasses, because of their usually being more abundant, is of more importance in connection with borer injury to corn outside of the sections where sugar cane is the principal crop than it is in these sections.

THE USE OF SKIM MILK IN THE PREPARATION OF CERTAIN SPRAY MATERIALS

By R. H. Robinson, *Chemist, Oregon Experiment Station*

Abstract

The advantages of using skim milk or milk powder in the preparation of certain sprays are discussed. A method is outlined for the use of milk in preparing a substitute for the different sulfur sprays used as summer fungicides. A mineral oil emulsion that may be prepared by using skim milk, and hydrated lime as an emulsifier is described. The use of skim milk, any of the condensed milks, or milk powder as a spreader is emphasized. These products will improve the spreading properties of the spray as well as calcium caseinate, and at a much lower cost.

The important requirements of a spray material are effectiveness without danger of injury to the plant or foliage, low initial cost, simplicity of preparation and facility of handling. Skim milk or the dried product is available at a reasonable cost in all sections of the country, and if utilized as a reagent for the preparation of certain sprays less labor will be involved and costs will be reduced. Investigations pertaining to the relation of surface tension of numerous substances to the spreading qualities of these materials disclosed the fact that milk, either the whole or the skimmed product, has a very low surface tension. This low surface tension of milk, even when very dilute, suggested its use in the preparation of substitutes for the sulfur sprays. Laboratory experiments confirmed the belief that the spray materials described below may be prepared with the aid of milk and substituted advantageously for those now in common use. It is the purpose of this paper, therefore, to report briefly the results of the laboratory observations.

Milk as a Wetting Agent For Lime And Sulfur. It is generally conceded that the various sulfur sprays used as summer fungicides are troublesome to prepare and disagreeable to apply. If lime sulfur is not used the more expensive commercial preparation must be obtained. If the spray is to be applied to tender foliage such as the peach tree, the self-boiled lime-sulfur must be home prepared. Often times this product is unsatisfactory due to the low grade materials used or to faulty manipulation of the method whereby the reaction is permitted to continue to the point where polysulfides of sulfur are formed. This form of sulfur subsequently may cause foliage burn.

The element sulfur is the active fungicidal ingredient in this class of sprays. Since powdered sulfur cannot be brought into water suspension easily, chemical or physical reactions are necessary to facilitate mixing with water. The peculiar physico-chemical properties of milk makes it especially well adapted for wetting finely ground sulfur after which it

may be introduced into the spray tank. Without reporting in detail the laboratory experiments a formula is given showing the amounts of ingredients that may be used to duplicate the proportions used in self-boiled lime-sulfur.

Sulfur, superfine flour	8 pounds
Hydrated Lime	4 pounds
Skim milk	2 quarts
Water to make	50 gallons

PREPARATION. The proper amounts of sulfur and hydrated lime are mixed together. An equal amount of water is added to the milk. This is then poured onto the sulfur and hydrated lime mixture, stirring meanwhile until a smooth paste is formed, adding more water as needed. After stirring to a creamy consistency several gallons of water are added, stirred well, and then poured through a strainer into the spray tank. Finally the required amount of water is added and the spray is ready for application.

The only precaution to observe is to use the best superfine sulfur or a form similar to that employed in dusting sulfurs. The amount of milk advised in the formula may be reduced by one-half, but the larger quantity is recommended in order to improve the spreading property of the spray. Other forms of milk may be substituted for the skim milk, such as whole milk, condensed whole or skim milk, or any of the milk powders. The amount of condensed milk found satisfactory is about one-fourth of the amount given in the formula; the dried product should be used at the rate of 2.5 ounces to the quart, or 5 ounces for the above formula. Slightly sour milk also may be used, provided it is first neutralized with a little hydrated lime.

Except when the above formula is to be applied to tender foliage there is no advantage in using so much hydrated lime. One-half pound of hydrated lime in the above formula should be sufficient to prevent any tendency to burn on foliage where summer strength lime-sulfur is used. The milk wets the sulfur as easily with .5 pound of hydrated lime as with 4 pounds of the lime.

The New Jersey Experiment Station[1] has carried on experiments with their "Dry Mix" sulfur-hydrated-lime-calcium-caseinate mixture, and has obtained better results in field tests than with any other sulfur spray. Equally good results should be obtained with the above formula where milk is used. It should likewise give as good or better results than are obtained with the commercial wettable sulfurs or the atomic-sulfurs.

[1]New Jersey Experiment Station Bulletin 379.

Milk as an Emulsifier of Mineral Oil. The standard dormant spray, lime sulfur, has failed to give satisfactory control of severe cases of scale in different parts of the country, while experimental tests have shown that the miscible oils and the home made fish-oil emulsions have given excellent results. Accordingly, the demand for oil emulsions has increased. Yothers[2] has outlined a method for the home preparation of engine oil emulsions by means of potash fish-oil soap. This method, however, involves considerable labor and the time necessary to prepare it is usually not available when the spray must be applied. Burroughs and Grube[3], improving upon the suggestions of Pickering[4], have developed several excellent methods by which different materials may be used to emulsify mineral oils. As these are prepared without the aid of heat they are referred to as "cold" emulsions. The procedures are short, and if care is exercised good emulsions may be obtained.

As a water soluble colloid having a low surface tension and a low interfacial tension to mineral oil, milk should be an excellent emulsifier for this class of oils. Laboratory observations made of many varied combinations indicate that the following formula will give good results.

Mineral oil	4 gallons
Water	1.5 gallon
Milk	1.5 quarts
Hydrated lime	2 ounces

Preparation. To make the emulsion the oil is introduced into a half barrel or other suitable container. The milk is added to the water and the hydrated lime or slaked quick-lime stirred in the diluted milk This is then poured into the oil, the mixture pumped back into itself for a minute and finally pumped into another container, using as high a pressure as possible, and with the opening in the nozzle reduced until a fine spray is obtained. It should then be pumped back again to give best results.

It is important to maintain as high a pressure as the spray pump can deliver in order to produce a smooth emulsion. A pressure of 200 pounds or more is desirable. A bucket pump may be used but the higher pressure pump is advised.

Hydrated lime is used to neutralize the acid reaction of the milk and to dissolve the casein. Sodium or potassium hydroxide or sodium carbonate may be substituted for the lime, but the latter is preferable, es-

[2]U. S. D. A. Clip Sheet 193, 1922.
[3]Journ. Econ. Entomology, V. 16, No. 6, 1923.
[4]Journ. of Chem. Society, V. 91, 1907.

pecially if hard water is used. It may be necessary to use more lime than advised above if the water is very hard. Whole milk or milk powders may be substituted for skim milk. The dried milk should be used at the rate of 2.5 ounces for each quart of milk necessary.

Several grades of mineral or lubricating oil were used and no difficulty was experienced in obtaining good emulsions with any of them. The so-called red-engine oil is recommended mainly on account of its low cost. The light or medium grade will give best results.

Burroughs and Grube[4] used commercial calcium caseinate, which is a mechanical mixture of about one part casein and two parts hydrated lime, as an emulsifier with excellent results, but were not so successful with milk. If, however, they had first added an excess of lime to the milk before using, they would not have experienced any difficulty. In fact, the milk emulsified easily a waste, crank-case oil but it was impossible to emulsify it with calcium caseinate. After the addition, however, of a small amount of commercial cresylic acid to the dissolved casein a good emulsion was obtained.

It was observed that under certain conditions a water-in-oil emulsion was formed instead of the oil-in-water emulsion which may be diluted with water without destroying the emulsion. This often happens when the proportion of water to oil is reduced. In order to facilitate the preparation of emulsions various materials were added to the emulsifiers to augment, if possible, their emulsification powers. Among the materials that apparently improved the emulsifying powers of milk and calcium caseinate were commercial cresylic acid, sheep dip, beechwood creosote, and creosote oil. It is recommended that about an ounce of commercial cresylic acid be added to the water in the formula given above.

THE USE OF SKIM MILK AS A SPREADER. The work by Lovett[5] on casein as a spreader suggested the possibilities of using milk as a substitute. Since casein is prepared from milk it is natural to expect that the latter likewise would have good spreading properties. Observations, however, made by spraying lead arsenate in diluted milk suspension, on apples and various leaves showed that there was no appreciable spreading. Instead the spray assumed the droplet form on the surface similar to water. Later, in a study of the surface tension of various spreader materials, milk showed low values indicative of a good spreader. Further study showed that very fresh milk would spread well on all surfaces on which calcium caseinate would spread, but after a slight de-

[5]Ore. Experiment Station Bul. 169, 1920.

velopment of acidity the spreading properties were destroyed. Neutralization by lime or other alkali restores its spreading propreties. Fresh milk normally is slightly acid, and under favorable temperature conditions rapidly develops higher acidity. Under comparatively low acid concentration the milk proteins are partially coagulated, thus destroying the spreading properties of the milk. By adding an excess of an alkali the proteins are again brought into colloidal solution and functions as a spreader. The commercial calcium caseinate is simply a mixture of hydrated lime and casein that has been precipitated from milk by the addition of a small amount of acid. When water is added to the mixture the calcium hydroxide brings the casein into colloidal solution which acts as a spreader.

The amount of milk that should be used to give good spreading of a certain spray depends upon the kind and the age of the surface to be covered. Manufacturers of casein spreaders recommend the minimum amount that will be most satisfactory under most conditions. This is oftentimes in excess and therefore a waste. Laboratory observations indicate that 3 quarts of skim milk or 7 ounces of skim milk powder to 100 gallons of spray is an average amount, and about half that amount the minimum that should be used. Two to eight ounces of hydrated lime, depending upon the spray and the age of the milk, should be added to the latter. For example, 2 ounces is sufficient for fresh milk as a spreader for lead arsenate, while 8 ounces should be used with sour milk or with lead arsenate—lime sulfur combination spray. The milk is then introduced into the spray tank nearly filled with water. Finally the spray material itself is added.

Leaves sprayed in the laboratory with lead arsenate and determinations made for the amount of arsenic that adhered showed no differences between milk or milk powder used as a spreader and calcium caseinate. Although it is generally recognized that calcium caseinate improves the spreading of various sprays, its use is limited on account of the high cost of the commercial product. Skim milk or skim milk powder will give equally good spreading if used in proper amounts, and may be obtained for less than one-third the cost of calcium caseinate.

THE STRIPED GRASS LOOPER, *MOCIS REPANDA*[1] FAB., IN TEXAS

By R. A. VICKERY, *Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

The striped grass looper (*Mocis repanda* Fab.) which has long been known as a serious pest of crops in Tropical America is occasionally injurious in Southern Texas. It was observed at Brownsville injuring Bermuda grass and sugar-cane in 1910, and destroying pasture grasses in 1916.

In addition to corn, sugar-cane, and Bermuda grass, the larvae fed on the following grasses: *Cenchrus viridis* Spreng., *Trichloris pluriflora* Fourn., *Eriochloa punctata* (L) Hamil., *Leptochloa nealleyi* Vasey, and *Panicum fasciculatum* Sw. The latter species appeared to be the favorite host plant.

Although the striped grass looper (*Mocis repanda*) has not been recorded previously as injurious in the United States it has long been known in Tropical America. It has been recorded as a serious pest of crops in the West Indies, in British Guiana and in Brazil. Bodkin, (9)[2] the British Government entomologist describing the damage done by this insect in British Guiana says: "On sugar-cane, rice, Paragrass and other grasses throughout the coast lands of the colony this moth may be found throughout the year and at certain periods, particularly on the occurrence of rain after prolonged drought, it appears in vast hordes completely destroying whole areas of the previously mentioned crops."

INJURIOUS OCCURRENCE IN THE UNITED STATES

The full grown larva is about 1-¾ inches long and $\frac{3}{16}$ inch wide, and is easily recognized by its slender cylindrical body, conspicuous brown stripes, and its habit of looping the body when in motion. In general habits these larvae resemble army-worms. They may occur in great numbers in a small area and completely defoliate the wild and cultivated grasses upon which they feed, leaving only the stems of small grasses and the stems and midribs of large grasses such as sugar-cane. When the food plants are destroyed the larvae migrate. The larval stages have been described by Dr. H. G. Dyar (1).

The larvae of *Mocis repanda* were observed by the writer first at Brownsville Tex., on October 18, 1910. They were feeding on Bermuda grass in company with army worms (*Cirphis unipuncta* Haw.). One larva was found feeding on sugar-cane, also in company with army worms. The larvae destroyed considerable Bermuda grass and damaged

[1]Lepidoptera, Noctuidae.
[2]Reference is made by number to "Literature cited."

the sugar-cane in the experimental plots of the "South Texas Gardens."[3] No further observations were made during that year.

On January 25, 1913 Mr. E. G. Smythe collected three of these larvae from an undetermined species of grass; and on July 5, 1914 the writer collected two larvae from Bermuda grass.

This insect was not observed again until September 21, 1916 when a report reached the laboratory that caterpillars were destroying the grass in a pasture. Inspection developed that the grass was practically destroyed in a field of about 300 acres. The most common grass was *Panicum fasciculatum* associated with other nearly mature grasses and weeds. There were larvae of various stages on the grass stems and on the ground, and they had eaten the leaves off most of the grass. There were many cocoons attached to the stems of the grasses and to weeds and many adults flew up as we walked through the field. Three species of caterpillars, *Cirphis unipuncta* Haw., *C. latiuscula* H. Schr., and *Mocis repanda* were located working damage in this field. The latter species was most numerous. There also were a number of *Laphygma frugiperda* S. & A., and a few Prodenia sp., the latter feeding on the weeds.

The larvae were found in another field about three miles from this one but no other extensive injury was located.

During another field trip on September 26, these larvae were found feeding on four species of grasses, *Cenchrus viridis*, *Trichloris pluriflora*, *Eriochloa punctata*, and *Panicum fasciculatum*, but they were most common on the latter species. The larvae did not appear to be damaging cultivated crops and they were not observed again doing damage to grasses, which was contrary to expectations, as the large number of moths found in the fields would indicate that all grass crops would be seriously attacked.

During the month of October the moths were observed to be very numerous flying around every where in the grass and weeds. On October 15 they were found to be rather numerous on the sandy ridges near the coast. They were also observed on the walls of public buildings in Brownsville at night between October 13 and November 6. Mr. T. S. Wilson collected a male adult at night November 26 and another from grass November 29, which were the last moths observed.

Food Plants

The moths of this species seem to prefer fields of grass of the genus

[3]A plant introduction garden maintained for several years by the United States Department of Agriculture on the Fort Brown Reservation, located on the Rio Grande river adjacent to Brownsville.

Panicum for oviposition but they also attack other wild or cultivated grasses and the larvae may migrate to cultivated plants from fields of grass. At Brownsville we observed the larvae feeding on corn, sugar-cane, and Bermuda grass (*Cynodon dactylon* (L) Pers.) in 1910, and on five species of grasses—*Cenchrus viridis* Spreng., *Trichloris pluriflora* Fourn., *Eriochloa punctata* (L) Hamil., *Leptochloa nealleyi* Vasey, and *Panicum fasciculatum* Sw.,—in 1916.

The larvae of Mocis repanda have been recorded as destroying Para-grass (*Panicum muticum* Forsk.), Guinea-grass (*Panicum maximum* Jacq.), and sugar-cane, in (5) Trinidad; sugar-cane, rice, Para-grass and other grasses in (9) British Guiana; Para-grass and Guinea-grass in (2) Barbadoes; Guinea-grass, alfalfa, sugar-cane, and millet in (10) Brazil; and sugar-cane in (6, 7, 8) Porto Rico.

Life History

No very extensive work has been done on the life history of this species. As it is a native of the tropics and adapted to feed on grasses, which may be found in a green state throughout the year in tropical countries and along the gulf coast of the United States, it does not hibernate and probably could not pass the winter north of the gulf coast section of this country. It resembles *Laphygma frugiperda* S & A, in this respect, and like Laphygma it also passes through many generations during the year.

During the fall of 1916 we carried on a few experiments in the laboratory at Brownsville to learn something of its life history. The entire life cycle from the time the eggs were laid to the time the adults appeared occupied 36 days during October and November at an average daily mean temperature of 76 degrees F.

The Egg Stage

Moths were placed in a large lantern globe and fed on a thin sugar syrup. Strips of paper and leaves of corn were placed in this cage, and the moths laid a few eggs on the corn leaves but they laid a larger number on the walls of the lantern globe and on the paper. The eggs were laid singly. Mr. T. S. Wilson worked out the egg stage during the month of November as given in Table I.

The Larva Stage

Eggs of *Mocis repanda* hatched October 9, 1916 and the larvae were reared in tin boxes. It was possible to rear many larvae in a single cage as they are not cannibalistic but it was more convenient to isolate the

TABLE 1. EGG STAGE OF MOCIS REPANDA, BROWNSVILLE, TEX., 1916

Eggs laid 1916	Eggs hatched 1916	Number of days	Average Temperature Degrees F.
Between 5 p. m.[4] Nov. 23 and 9 a. m. Nov. 24	December 1	7	69
Between 5 p. m. Nov. 24 and 9 a. m. Nov. 25	December 1	6	70
Between 9 a. m. Nov. 26 and 9 a. m. Nov. 27	December 2	5	72.5

larger larvae in tin boxes, where they were fed on corn leaves. Pupation began October 30 which would make the length of the entire larval stage from egg to pupa 21 days at the temperature of the laboratory or an average daily mean temperature of 76–½° F. When preparing to pupate the larvae fasten together leaves to form a cocoon, using only enough silk to fasten the leaves and spin a thin protection around the larva. The prepupal period occupied from 24 to 36 hours.

THE PUPA STAGE

The pupation period for 12 pupae was observed in the laboratory from October 23, to November 13, 1910. The number of days varied from 10 to 14, the average being 12. The temperature was not recorded. A few larvae pupated October 30, 1916, and the adults emerged November 9. The time was 10 days at an average daily mean temperature of 77° F. The pupation records of eight larvae which pupated during the latter part of September are given in Table II.

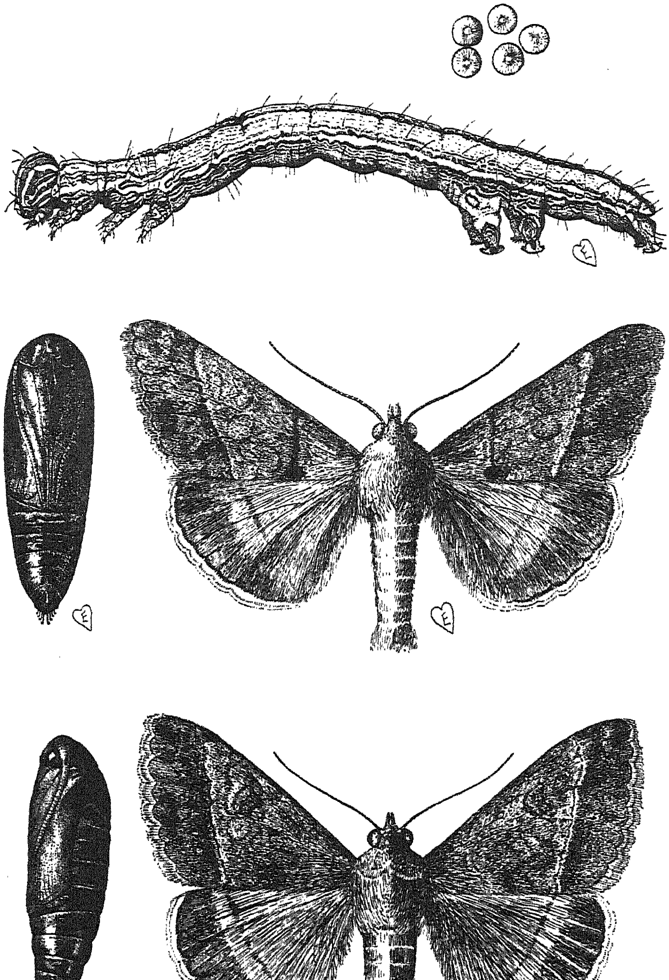
TABLE II. PUPAL PERIOD OF MOCIS REPANDA, BROWNSVILLE, TEX., 1916

Number of larvae	Pupated 1916	Moth emerged 1916	Number of days	Average temperature degrees F.
2	Sept. 29	Oct. 7	8	79
1	Sept. 25	Oct. 2	7	81
1	Sept. 25	Oct. 3	8	81
4	Sept. 25	Oct. 4	9	81

NATURAL ENEMIES

No parasites of *Mocis repanda* were reared during our observations on this species at Brownsville, although large numbers of larvae and pupae were collected for this purpose, 161 larvae being taken in one collection. Mr. T. S. Wilson collected a small larva feeding on the grass *Leptochloa nealleyi* Vasey on November 22, which had two Euplectrus

[4]All references to clock time refer to "Standard Time."



1

2

3

1.—Side view of larva; 5 eggs above; all enlarged.
2.—Male, also ventral aspect of a pupa.
3.—Female, also lateral aspect of a pupa.

larvae attached to it, but we were not successful in rearing the adults. This was the only case of parasitism observed.

The following natural enemies have been recorded in the literature: In Trinidad, Urich (5) mentions blackbirds (*Quiscalus crassirostris*, *Crotophaga ani*) and parasitic flies. In British Guiana, Bodkin (9) records the Demerara robin (*Leistes guianensis*), the ladybird beetle (*Megilla maculata*), and a bacterial disease. In Porto Rico, Van Dine (7) records a carabid beetle (*Calosoma alternans* Fabr.), blackbirds (*Crotophaga ani*, *Holoquiscalus brachipterus*) and a tachinid fly (*Linnaemya fulvicauda* Walton). In Brazil, Hempel (4) records an undetermined tachinid, and a hymenopterus parasite in small numbers, and several species of birds.

Control Measures

No experiments were tried with control measures at Brownsville, but measures similar to those used for army worms would probably be useful.

In British Guiana, Bodkin (9) advises burning of badly infested fields of grass when the insect is in the pupa stage in order to prevent further infestations. For infested rice in the nursery beds he recommends flooding. For sugar-cane he recommends the use of arsenate of lead although the usual method employed is hand picking the larvae. In Brazil, Hempel (4) recommends the burning of infested grass and the use of furrows to confine the migrating larvae.

Literature Cited

There is an extensive literature on this species including about 22 titles of economic importance and about 20 titles in the faunistic and systematic literature. The articles referred to in this paper are listed below.

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10. 1914. Hempel, A. A Lagarta do Milharal., O Fazendeiro, S. Paulo, vol. VII, no. 3, March, p. 110.

THE SPOTTED CUTWORM, *AGROTIS C-NIGRUM* (L), A CRANBERRY PEST[1]

By H. J. Franklin and D. S. Lacroix

During the summer of 1923, severe outbreaks of the Spotted Cutworm, *Agrotis c-nigrum* (L.), occurred on several cranberry bogs in southeastern Massachusetts. The infestations developed quickly and most of the crop on the infested areas was destroyed before treatment could be applied to advantage. The activities of this pest became evident almost simultaneously on thirteen widely separated bogs in the towns of Kingston, Middleboro, Rochester, Carver, Wareham, Barnstable, Harwich, Orleans, and Chatham, during the latter part of July. It was estimated that the total area infested was about 200 acres and that the possible loss was 10,000 barrels of berries, representing a money loss of $60,000.

The first indication of the work of this insect was the sudden disappearance of the cranberry blossoms. Also, many fallen green leaves appeared in the bog ditches.

The larvae, which were nearly all full grown by the last week in July, were found during the day among the litter of dead leaves on the bog bottom. At night they climbed the cranberry uprights and fed by cutting off the flowers at the distal end of the pedicel and dropping them. Later, they cut off the small berries in the same way. They also cut off many leaves, apparently devouring but little of them. This accounts for the fallen green leaves seen first along the ditches and later everywhere under seriously infested vines. The most severe infestations so defoliated small areas of bog that the bare uprights gave some of the vines a brown tinge when viewed from a distance. When the berries had attained some size, the worms ate into many of them more or less, often devouring the interior and leaving only the outer portion.

Of the two most widely grown cranberry varieties, the Early Black and the Howes, the latter generally was preferred by the larvae. On bogs having these varieties on adjoining sections, the infestation often seemed to stop where the Early Black sections began.

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[1]The observations reported here were made by the authors in research conducted by the Massacusetts Agricultural Experiment Station.

In Massachusetts most cranberry bogs are covered with water during the winter. Sometimes this winter flood is let off in early April and sometimes it is held until late May or early June. On ten of the infested bogs, comprising a total of 165 acres on which the crop was a total loss, the winter flowage had been let off between May 28 and June 5; one infested bog, on which an area of only 5 acres was seriously affected, had been drained of winter flowage in April; one bog of about ten acres had the winter water let off in April, was flooded again May 16, and finally drained June 1st. One bog was drained of its winter flowage in April but water backed in onto the lower part from an adjoining bog, the latter having been held under water until May 28. A heavy infestation appeared on the bog drained May 28 and also on the low part of the adjoining bog which had been drained in April. These facts suggest that damp soil in very late May and early June invites infestations of this insect, possibly because the female moths prefer to lay their eggs in damp or slimy earth. They also show that the pest does not attack cranberry bogs much unless the winter water is held until late May.

About 700 larvae were collected for rearing. These worms were nearly all full grown, and pupating began almost at once, continuing from about August 1 to August 25. The greatest number of larvae pupated the second week in August. The time spent as a pupa averaged 19 days, being never less than 17 nor more than 24 days. Pupation took place in the rearing cans about three inches below the surface of the sand. On the bogs, pupae were found at depths of one to four inches.

Adults in the rearing cans began to emerge August 20 and continued coming out until nearly the middle of September, the height of the emerging period being through the first week in September. The moths died rapidly without laying eggs. One female was kept alive much longer than the others by feeding her with a sugar solution, and she deposited several eggs on sand and on the sugar container. These eggs were spherical, about .75 mm. in diameter and fluted. They were laid September 15 and hatched September 29. The young larvae would not feed on clover, newly sprouted corn, ferns or cranberry leaves and they died in the first instar.

No adults were seen on any of the infested bogs.

Over 70 per cent of the worms gathered for rearing bore eggs of dipterous parasites, as many as eleven being found on some. In most cases the host failed to reach pupation. Records were kept of all the parasites that emerged. The Red-tailed Tachina Fly, *Winthemia quadripustulata* Fabr., was the most abundant, about 65 per cent of the

worms being parasitized by this fly alone. Other parasites reared are *Phorocera claripennis* Macq. (Dipt.), *Amblyteles seminiger* Cress. (Hym.), and *Euplectrus bicolor* Swederus (Hym.). The last named was identified by Mr. A. B. Gahan of the Bureau of Entomology, and Dr. L. O. Howard informs us that it is an important parasite of cutworms in Europe. This is probably its first recorded appearance in North America.

Agrotis ypsilon Rott., the Greasy Cutworm, was found occasionally along with the Spotted Cutworm, but not in numbers to do appreciable harm. When placed in rearing cans with *A. c-nigrum*, the Greasy Cutworm larvae proved very carnivorous, rapidly devouring the Spotted Cutworm larvae.

Agrotis c-nigrum has been known to injure limited cranberry areas occasionally in previous years, the outbreak in every case observed being on a bog on which the winter water had been held late, but no cranberry grower recalls a former instance of any such extensive injury as occurred in 1923. Evidently, this was a Spotted Cutworm year. It should be stated that, in addition to the marked activities of the pest described above, a few of the worms and scattering marks of their work on the blossoms and berries could be found on most of the Cape Cod bogs.

This is the fourth species of cutworm now known to infest cranberry bogs seriously as a result of holding the winter flood very late, the others being the Army Worm (*Cirphis unipuncta*), the Fall Army Worm (*Laphygma frugiperda*) and the Greasy Cutworm (*Agrotis ypsilon*).

A DEVICE FOR INFLATING LARVAE

By F. H. Mosher and J. E. R. Holbrook, *Gipsy Moth Laboratory, Melrose Highlands, Mass.*

Since 1911 it has fallen to the lot of some of the assistants at the Melrose Highlands Parasite Laboratory to inflate the larvae, not only of the gipsy moth and the brown-tail moth, but of many other lepidopterous larvae of native species to be used for cabinet specimens. Many of these are hosts of the parasitic and predaceous insects imported to hold the gipsy moth and the brown-tail moth in check.

With the devices first used the air pressure was obtained by a bulb pressed by the hand or by a bellows operated by the foot. The former was very tiresome and the operator had but one hand to arrange the larva and only one specimen could be inflated at a time. With the second

method the larvae were usually much distended and had a very unnatural appearance.

The amount of inflating work has increased greatly since the work was started in the spring of 1911 and the devices described here have been worked out by those having the work to do. Mr. C. B. Russell, who worked for several years in this Bureau, perfected a device by means of which compressed air can be utilized, the flow being regulated by needle valves. The tubes with the points and clips were in use on other inflating devices. The glass tube back of the clips so that a tip can be slipped off and another placed on after a specimen has been put in place, was designed by Mr. Holbrook.

A great demand for inflated larvae of the gipsy moth and brown-tail moth was the cause of this apparatus being assembled at the Gipsy Moth Laboratory, Melrose Highlands, Mass. This has eliminated some of the tedious operations experienced by those engaged at this task and made the results more satisfactory.

In the process of inflating, the two most necessary elements for good work and speed are a steady supply of air pressure and a sufficient adjustable amount of heat to meet requirements.

The apparatus and accessories being used at the Gipsy Moth Laboratory are neither complicated nor difficult to assemble. The outfit consists of two units, namely, the oven and an air pressure tank.

The oven is of ordinary galvanized iron 9″ long, 7″ deep and 11½″ high. Six inches from the bottom a horizontal metal partition divides this space into two chambers, an upper and lower. The backs of both chambers are closed, the lower with metal and the upper with glass to admit light. The fronts remain open thus permitting the operator to inspect the gas burner in the lower and attend to the specimens in the upper chamber. Attached to the bottom of the front of the upper chamber are 2 pairs of metal clips that are used for holding the subjects over the heat. These clips are made of a ½″springy metal 3½″ tall and are spaced 3¼″ between pairs.

The air pressure reservoir is a Galvanized Expansion Tank ordinarily used in buildings heated by a hot water system. The pressure is forced into the tank with a bicycle pump through a valve stem placed in a ½″ opening near the base.

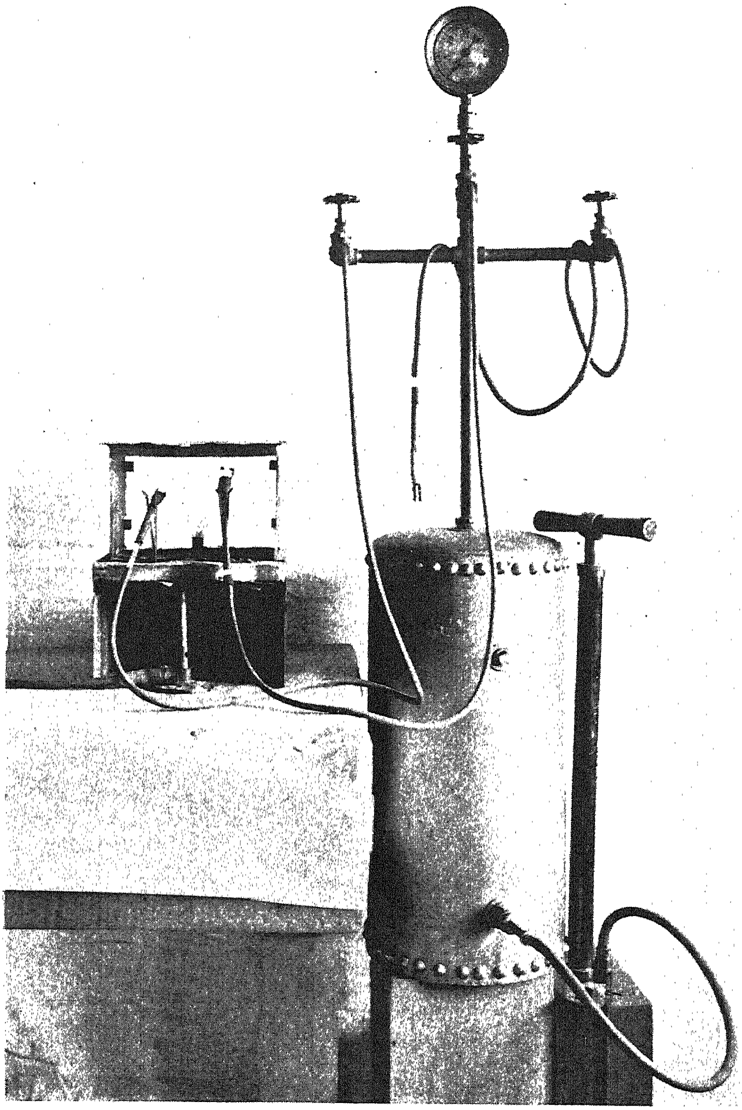
The tank was provided with a number of openings, some not being needed for our purpose. These extra holes were sealed with plugs such as are commonly used on steam boilers.

The various materials used in constructing the apparatus can be secured from firms dealing in plumbing supplies, and are as follows:

1 Galvanized Expansion Tank—20 inches high, 10 inches diameter, 8 gallons capacity.
1 ½″ x ⅜″ brass reducing coupling
1 ½″ close nipple
1 bicycle pump
2 1″ plugs
1 ½″ plug
1 1″ x ½″ bushing
1 pc. ½″ pipe, 13″ long
1 ½″ x ⅜″ cross
2 pieces ⅜″ pipe, 5¼″ long
2 ⅜″ elbows
1 ½″ short space, 1¾″ long
1 Reducing Tee, ½″ x ⅜″ x ⅜″
1 ⅜″ Nipple, 3¼″ long
1 ⅜″ x ¼″ reducing coupling
1 3½″ Pressure gauge, 30 lbs. capacity
3 No. 82 Brunner Needle Valves, with No. 81 Swivel hose connections
3 3 ft. pieces ⅛″ hose rubber tubing
3 ⅜″ leather washers

The automobile tire valve is soldered into the ½″ x ⅜″ brass reducing coupling, attached to the ½″ close nipple and placed in the lower hole intended for a water gauge glass. The upper gauge glass hole is plugged with a ½″ plug. A 1″ hole in the bottom and another in the side of tank are plugged with 1″ plugs. The bushing 1″ x ½″ is placed in the opening on the top surface, from which a ½″ pipe 13″ long leads to the ½″ x ⅜″ reducing cross. Each piece of the ⅜″ pipe 5¼″ long is set into the sides of the cross, being fitted with a ⅜″ elbow into which a Needle Valve is connected. The ½″ short space 1¾″ long continues from the top of the cross to the reducing tee ½″ x ⅜″ x ⅜″ which is fitted, off the run, with the remaining Needle Valve. The ⅜″ nipple 3¼″ long is continued from the top of reducing tee to the ⅜″ x ¼″ reducing coupling into which the pressure gauge is fitted. One end of each piece of the ⅛″ rubber tube is placed in the hole of a ⅜″ leather washer and worked onto the ¼″ hose nipple, making a tight connection. The end of a ¼″ glass tube 4″ long is placed in the extreme end of each rubber tube, the free end of glass is used as a connection for attaching the inflating tips.

The inflating tips are made up of ¼″ glass tubing drawn to various degrees of fineness, being 3″ long when finished. Two inches of the proper end is inserted in a ⅛″ rubber tube 5″ long; 2″ of 2 thin strips of copper



Device for inflating larvae

¼″ wide and ¾″ long are bound on opposite one another with an adhesive tape having only one side treated. A portion of these protruding ends are bent at a right angle towards the glass tip and adjusted so that the lower strip will grip the caterpillar slightly ahead of the anal prolegs. The upper strip is not used except in cases when the lower one is not holding well. An elastic band is slipped around these holders after the caterpillar is arranged and the upper strip bent upward enough so it does not interfere. These tips are placed in the clips in the oven and the drying proceeds. Extra tips should be provided so that a specimen can be prepared while the others are in the oven.

This device has relieved much of the monotony of this work and greatly increased the quality as well as the quantity of the specimens. An operator with a little experience can easily inflate fifty large larvae the size of full grown gipsy moth larvae in a day and many more than that if the larvae are smaller or thin skinned.

The air pressure should not exceed 15 pounds and 10 pounds is better. Over 15 extends the specimen too much and gives it an unnatural appearance. The larvae were placed in a cyanide bottle for a few minutes before they were rolled and inflated.

First stage larvae bothered considerably at first as they were so small it was difficult to get a point fine enough to inflate them. It was found that by placing these small larvae on the top of the oven and keeping them moving, in a short time the air within the body would expand and cause them to "pop." These "popped" specimens were then mounted on card points. A few of these will "pop" through the side and spoil the specimen.

The cost of this device was a little less than twenty dollars (prewar prices) and will soon pay for itself in the greater number of specimens inflated.

NOTES ON THE PEAR MIDGE (*CONTARINIA PYRIVORA*).

By Lawrence Paul Wehrle

During the summer of 1922, while engaged in a study of the pear midge (*Contarinia pyrivora* Riley) the writer made some observations which it seems desirable to record at this time.

The pear midge first attracted special attention in Connecticut in 1884 and seems to have been introduced on pear stocks from France in 1877. Although this insect was probably described by Meigen as *Diplosis nigra* the type specimens had been lost and Riley in 1885

redescribed the species. He proposed the name *pyrivora* to be used if *nigra* is really a lost species or if the species in America should prove to be different from that in Europe. The name *pyrivora* is now used to designate the species in Europe and America.

There is some infestation by the pear midge at Ithaca, New York and on May 26, 1922, several badly infested trees were found. At that time the larvae were nearly all grown and some of them had already left the fruits. There were a good many fruits on the ground with larvae in them and many of the fruits remaining on the trees were also infested. When infested the fruits have black spots and holes on the outside and become hollow and discolored on the inside and are soft. Some of the fruits also become somewhat elongated and occasionally are found to be entirely black and decayed.

Pears were collected from the infested trees and from the ground under the trees. The larvae were found to be very numerous in the fruits. Two average sized selected fruits collected May 17 and examined May 18 yielded 18 and 37 larvae respectively.

On the evening of May 26, 1922 over a hundred pear midge larvae were obtained from the infested fruits collected that day and were placed in individual vials and salve boxes. The following interesting characteristic was noted. When crawling along or lying on a horizontal surface the larva would draw up its anterior and posterior ends close together until its body was in the form of an arch. Then it would let go like a spring and the larva would throw itself quite a distance in this way. One larva jumped one and one-fourth inches in one jump and another jumped one and one-half inches in one jump. A third larva jumped two and one-half inches in one jump and in a little while this same third larva jumped two inches in another jump. A fourth larva was noted to jump to the height of one and one-fourth inches. This jumping characteristic has been reported by other writers.

On August 30, 1922, soil was collected from under a pear tree the fruit of which was infested in the spring. Some of this soil was examined and four cocoons of the pear midge were found. It is evident that the cocoons are formed from one-half to one inch beneath the surface as only the very thin top layer of soil was collected for examination. The cocoons were pale colored and eliptical in shape. The cocoons were examined and it was found that the insect was still in the larval stage.

Time of Pupation:—There seems to be some uncertainty among writers as to the time of pupation of the pear midge.

The specimens on which this study is based were collected May 26,

1922. On the same day some of the larvae were put on moist soil in individual vials and others were placed on moist soil in salve boxes. On June 10 the larvae in the salve boxes were removed to moist soil in petri dishes. Later these larvae were also transferred to moist soil in individual vials. The vials were kept in salve boxes in an out-door cage and were all later numbered. An attempt was made to keep the soil in a uniform moist condition and observations were made on the specimens throughout the summer. Pupation was found to begin in very late August or early September and continued throughout September and early October. One specimen was observed to be in the process of pupation as late as November 27, 1922.

TABLE 1. TIME OF PUPATION, 1922

Specimen Number	Date Larva Collected	Date of Pupation
114	May 26	Aug. 25—Sept. 2
61	"	Sept. 2–8
62	"	" "
5	"	" "
13	"	" "
15	"	" "
19	"	" "
22	"	" "
28	"	" "
35	"	" "
41	"	" "
47	"	" "
52	"	" "
57	"	" "
112	"	" "
4	"	Sept. 9
20	"	" "
23	"	" "
53	"	" "
63	"	" "
119	"	" "
117	"	" 10
17	"	" 11
43	"	" "
65	"	" "
42	"	" 12–14
6	"	" 15
55	"	" "
58	"	" "
12	"	" 17–20
48	"	" 22

16	May	Sept. 23
115	"	" "
64	"	" 24
124	"	" "
1	"	" 24–27
30	"	" "
122	"	" "
2	"	" 28–Oct. 2
26	"	" " " "
116	"	Oct. 2–5
121	"	" 9
113	"	Nov. 27

MULLEN ROSETTES AS WINTER SHELTERS FOR INSECTS

By W. L. McAtee

The common mullen (*Verbascum thapsus*) is a biennial which passes the winter in the form of copious rosettes closely applied to the ground. The leaves are so densely wooly as to have earned for the plant such vernacular names as flannel-leaf and blanket-leaf. Their obvious suitability for sheltering hibernating insects led me to make some investigation of the matter several years ago. While no further notes have been taken, it is hoped that even these scanty data will be of some interest.

All of the examinations were made in an old field on the Maryland shore near Plummers Island, and were conducted at various dates, ranging from November 25 to April 5 in the years 1914 and 1915. An account will be given of the largest collection of insects made from a single rosette, and also a list of additional species taken on other occasions.

Insects Taken From a Single Rosette, January 25, 1914

Heteroptera
Heraeus plebejus Stal., 1.
Ptochiomera nodosa Say, 19.
Nabis sp., 1.
Lygus pratensis Linnaeus, 3.

Homoptera
Erythroneura vulnerata Fitch, 1.

Coleoptera
Stenolophus conjunctus Say, 5.
Astenus sp., 3.
Conosoma, sp., 2.
Atheta sp., 2.
Gymnetron tetrum Fabricius, 4.

Hymenoptera
Ant, 1.

Total 10 species, 42 individuals.

Other Insects Found Hibernating in Mullen Leaves

Heteroptera
Thyreocoris ater Amyot et Serville
Lygaeus kalmii Stal.
Ischnorhynchus resedae Panzer.
Geocoris uliginosus Say.
Crophius disconotus Say.
Pselliopus cinctus Fabricius.
Orius insidiosus Say.

Coleoptera.
Amara crassispina LeConte.

Casnonia pennsylvanica Linnaeus	Anaedus brunneus Ziegler.
Pinophilus latipes Gravenhorst	Chalepus dorsalis Thunberg.
Languria mozardi Latreille.	Hypera punctata Fabricius.
Melanophthalma americana Mannerheim.	Chalcodermus collaris Horn.
Acylomus ergoti Casey.	Tyloderma foveolata Say.
Calathus gregarius Deean.	

Besides these adult insects, a nymph of a reduviid and of an unidentified heteropteron, two carabid larvae, some cutworms and spiders were found among the mullen leaves.

Scientific Notes

Oriental Fruit Moth. Among the interesting observations on the activities of *Laspeyresia molesta* this spring was a flight of moths on May 6. On this date,during the morning and at midday the adults were plentiful; flying about in the orchard and resting on the foliage and stems. Mating pairs were noted. Contrary to the statements in several publications on the subject the adults were very active during this bright sunny day, temperature about 82 to 85, no wind, in fact the warmest day of the spring.

A. B. Champlain
T. L. Guyton

Notes on the Life History of ***Disonycha laevigata*** Jacoby in Porto Rico. This shining green flea beetle has been known from Jamaica and Santo Domingo for some years, but was noted at Gúanica, Porto Rico in August 1921. The writer found it abundant at the College and Experiment Station grounds at Mayagüez in September 1921. A note upon its food plants, by Mr. G. N. Wolcott, Entomologist of the Insular Experiment Station at Rio Piedras, appeared in the Journal of Economic Entomology for October 1923.

In the college year 1922–23 Messrs. Rafael Bemúdez and Armando Arroyo and other students worked out the life history of this new pest of beets and chard in Porto Rico, also life histories of two other flea beetles, *Oedionychis cyanipennis* Fabr. and *Haltica occidentalis* Suffrian, but as neither of these latter species are pests of cultivated plants in Porto Rico, so far as known to the writer, space will be taken here to record only the notes on *Disonycha laevigata* Jac. which is a serious pest.

The adult is about 4.5 mm. long, the female being larger than the male, with glossy green elytra, which in some of the dried specimens change to deep blue. The head, thorax and abdomen are orange as are also the legs excepting the distal portions which are dark. The eyes are black and the greater portion of the antennae dark. They hop very freely and fly rapidly. During the hours of hot sunshine most of them hide on the lower surface of the leaves or in crevices.

The eggs are of a soft shade of terra cotta to grenadine red, fusiform, and beautifully fretted with minute pits in honeycomb pattern, and are either glued to the underside of leaves or deposited upon the soil near the stem of the plant. They hatched in from four to seven days, the majority of the egg clusters hatching in five days. The larva emerges from the side of the egg, near the apical end, when the other end is attached to a leaf, leaving a yellowish white chorion.

The newly hatched larva is pink with dark yellow head. The full-grown larva is light grey and about one centimeter in length. It has rows of hairs with round, semitransparent tips. If the leaves on which they are feeding are disturbed the larvae fall to the ground. The larval period lasts from 11 to 14 days. The prepupal stage lasts one day. The pupa is yellow until shortly before emerging. The pupal stage is spent underground and lasts 7 days in most cases, 6 days in one instance. The adult remains in the pupal cell a few hours until the wings are hardened, then crawls out and begins feeding on the leaves.

The total time from newly hatched egg to adult was usually 26 days. In three days more the adults were mating.

RALPH E. DANFORTH, *College of Agriculture and Mechanic Arts, Mayagüez, P. R.*

Hydrocyanic Acid Retained by Fumigated Cheese. Messrs. E. R. de Ong and C. L. Roadhouse have recently published the recommendation that cheese may be fumigated with hydrocyanic acid gas for the destruction of certain cheese pests ("Cheese Pests and Their Control," Calif. Exp. Sta. Bul. 343, May, 1922). The ability to use this gas with safety in cheese rooms without removing the cheese is much to be desired and in connection with his work with the cheese skipper (*Piophila casei* L.) the writer made several preliminary tests of the advisability of using this fumigant. He is indebted to Dr. R. E. Holm, Division of Virus-Serum Control, Bureau of Animal Industry, U. S. D. A., for the analyses of the fumigated cheese. A review of the experiments and results follows.

Oct. 10–11, 1921. Fumigating box, 100 cu. ft. Charge 4 oz. NaCN, 6 oz. H_2SO_4, 8 oz. water. Temperature at start about 55° F.; relative humidity about 80%. Exposure of cheese 10:30 A. M. to 8:45 A. M. Cheese tested: Camembert, Cheddar and Swiss, the pieces being roughly 3 x 3 x 3 inches. One side of each piece freshly cut and marked. Gas not strong when box opened. Analysis showed considerable HCN in the cheese, especially in the Camembert; least in the Cheddar. The gas in the cheese much reduced after airing for about one day.

Oct. 17–18, 1921. Fumigating box the same, but repaired to reduce leakage. Charge 2 oz. NaCN, 3 oz. H_2SO_4, 4 oz. water. Temperature about 63° F.; relative humidity 89%. Exposure of cheese 3:00 P. M. to 9:30 A. M. Gas strong when box opened. Cheese tested, same as in first trial. Analyses showed that a large amount of acid was retained, even after airing for about one day. After this airing, more acid was present in the center of the cheese than near the surface, due, probably, to slower dissipation from within.

Oct. 18–19, 1921. Fumigating box the same. Charge 1 oz. NaCN; 1½ oz. H_2SO_4, 2 oz. water. Temperature about 65° F.; relative humidity 80%. Exposure of cheese 11:00 A. M. to 10:00 A. M. Temperature steadily declined to 55° F. at end of trial. Migrant skipper larvae used as indicators of efficiency of the fumigation were killed; these were exposed in Petri dishes. Cheese aired for 24 hours before being sent to Dr. Holm's laboratory. Analyses showed that HCN was found in all the samples, but the concentration in the Cheddar amounted to a mere trace.

On account of the tenacity with which skipper larvae cling to life in the presence of hydrocyanic acid gas, especially when embedded in their food materials, the writer feels that dosages up to and including one ounce per 100 cu. ft. would be largely wasted. Cheese mites also are reported to be very resistant to this gas. It would

not be safe to assume that all cheeses in a given room were protected by an unbroken coating of paraffin, and in view of the very evident tendency of cheese to retain this poisonous acid and the fact that cheese is not usually cooked before being eaten, (a process which would be expected to aid the volatilization of the retained acid), the writer feels that until more extensive tests are made to prove otherwise, in regard to each variety of cheese, cyanide fumigation of cheese should not be recommended.

PEREZ SIMMONS, *Entomologist, Stored Product Insect Investigations, Bureau of Entomology, U. S. Dept. Agr.*

Calcium Cyanide Dust for Rosy Apple Aphis. On June 21, 1923 eight and one-half Gravenstein and two Baldwin apple trees, twenty-five years old, were dusted between two and four P. M. with Calcium Cyanide dust (twenty-five percent calcium cyanide, seventy-five percent talc) for the control of *Aphis sorbi*. The total amount of dust used was twenty-five pounds, an average of about three pounds per tree. The tests were conducted in the A. J. Schaefer orchards situated in Ulster County near Plattekill, N. Y. The applications were made with a Dosch hand duster.

Weather conditions were almost ideal for dusting; there had been no rain for several days preceding or subsequent to the application; temperature at the time of the applications was 92° F.; relative humidity 85%; southwest winds of about three miles per hour prevailed.

The undersides of the leaves on all of the trees were heavily infested with both winged and wingless forms of *Aphis sorbi*. After each application, the trees were shaken to dislodge the insects. The following forms were caught on sheets under the trees: *Aphis sorbi*, ants, bees, rose leaf beetles. The average quantity of insects caught on one sheet measuring seven feet by three feet was upward of three cubic inches of insects.

The first examinations were made about five minutes after each application—at the time the trees were shaken. The next examinations were made about ten hours later. While a small percentage of the total catch still seemed to be alive at the time of the first examination, there was apparently no survival at the time of the second examination.

Later examinations of the trees during the season revealed no injury to either fruit or foliage as a result of the applications. At the time of the tests, the average size of the fruit was about one inch in diameter. Some of the infested leaves had already curled.

C. C. WAGONER, *Highland, N. Y.*

Note on the Squash Beetle (*Epilachna borealis* Fab.). Under the caption "Squash Pest," Mr. Wyatt W. Jones, writing in the JOURNAL OF ECONOMIC ENTOMOLOGY of February, 1924 (Vol. 17, page 176), calls attention to the occurrence of this species at Douglas, Arizona, attacking all kinds of cucurbits, including *Apondanthera undulata*. The writer received two specimens from Mr. Jones which correspond very closely to what Gorham[1] considers typical *borealis*, the only observable difference being that in the case of Mr. Jones' sending, in one specimen the elytral black dots are a little smaller and the prothorax is unspotted. In a series of a similar lot with spots a little larger, received from Mr. E. G. Smyth and collected at Guatemala City, Guatemala, in 1923, in one example the median thoracic spot is present and the others

[1]Biologia Centrali-Americana, Coleoptera, Vol. 7, p. 241, Pl. 13, Fig. 12.

are indicated. There is no reasonable doubt of the identity of this variation with the *borealis* of the North. In the Northern States the species is more brightly yellow and has larger black spots, and it is true that the Arizona specimens do have somewhat the appearance of *corrupta* Muls., being of about the same size as large specimens of the latter species; so the entomologists at Phoenix are not to blame for stoutly maintaining that this is a variation of the bean beetle. In other words, the extremely small dotted specimen received does present more of the appearance of *corrupta* than it does of the northern *borealis*. At this point it is interesting to remark that few species of beetles have such an extreme geographical range as *borealis*, which extends from Canada and New England through Central America into South America.

F. H. CHITTENDEN

A New 'Canker-Worm.' In the spring of 1923 the larvae of a Geometrid moth, *Coniodes plumogeraria* Hulst, totally defoliated over forty acres of walnut trees in the Simi valley, Ventura County, California.

According to H. G. Dyar this moth is not closely related to *Paleacrita vernata*. Like the latter, however, the female is wingless and the larvae have two pairs of prolegs. They also pupate in the ground and emerge in the spring.

There appears to be only one brood a year. This year the moths commenced to emerge the middle of February and the eggs to hatch the middle of March. Most of the eggs observed were deposited on twigs killed the previous seasons.

The wings of the male are silver-gray. The forewings are transversed by narrow wavy brown bands; four on each wing, the distal being most distinct. The characteristic marking on the hind wing is a brown spot near the center. The wing expanse measures 4½ centimeters from tip to tip. The antennae are light brown and beautifully plumose.

The female is brownish-gray. Ventrally, the abdomen is light gray; dorsally, it is tinged with bronze. In length the female measures 1 to 1½ centimeters.

The eggs are ovoid and slightly ridged. When first laid they are of an iridescent bronze but when about to hatch they are of a light blue.

The newly-hatched larvae are black with white patches along the lateral line. After feeding they turn brown but the white patches remain distinct for some time. The integument is sparsely covered with hairs and spined tubercles.

It is noteworthy that the infested orchard is some distance from any native growth and intervening orchards are apparently free.

STANLEY E. FLANDERS, *Entomologist, Saticoy Walnut Growers Assn.*

Woodpeckers and Smartweed Borer. In February, 1924, the State Entomologist at Ames, Iowa, received a package of dry corn stalks from Henry Marshall of Clear Lake, Iowa. They were found to be infested by larvae of the smartweed borer, *Pyrausta ainsliei* Heinrich. The sender stated in his letters that there seemed to be about two or three acres of stalks thus heavily infested in rather low ground. His attention was attracted by the activity of a number of downy woodpeckers, (*Dryobates pubescens medianus* Swainson). Though the day was bitterly cold and the field three-quarters of a mile from any kind of trees or shelter, yet these birds were busily pecking the stalks to pieces. Examination proved that they were getting about 90% of the larvae. There seemed to be little or no promiscuous prospecting on the part

of the woodpeckers, as they had evidently been able to locate the larva exactly in almost every instance. Because of the similarity of habits between the smartweed borer and the European corn borer, this bird may be especially worth encouraging in sections where the latter insect abounds.

J. E. GUTHRIE

NORTHEASTERN ENTOMOLOGISTS, SIXTH ANNUAL SUMMER MEETING, JULY 16-18 INCLUSIVE, 1924

The committee has prepared the following program for the field meeting for the summer of 1924:

JULY 15, TUESDAY

Headquarters for the evening to be at some hotel in Philadelphia where the rates are reasonable, and to which access by automobile and train is convenient. It is believed that hotel accommodations can be secured at rates from $2.50 to $3.00 for the night. Those coming to the meeting by train or by machine who are to spend the night in Philadelphia can be accommodated. It is not planned to have any formal program for the evening, but those present can visit informally.

JULY 16, WEDNESDAY

Leave the hotel at 9 a. m., daylight time, by machine, making first stop at Holmesburg, arriving there about 9:45 a. m., daylight time. Leave Holmesburg at 10:15 a. m., arrive at Bustleton 10:30 a. m., daylight. Those coming to the meeting by machine, but not arriving the previous evening, can meet the party at either of these two points, and may then proceed on the rest of the trip with the main party. Leave Bustleton at 11:30 a. m., arriving at Willow Grove at 12 noon, leaving 12:30, and arriving at Gwynedd at 1 p. m. Arrangements will be made to have lunch here, and leaving here at 1:40 p. m., arrive at West Chester about 5 p. m., on the way spending a few minutes at Valley Forge. Supper will be secured at West Chester from 5:30 to 6:30 p. m., and it is planned to spend the night at West Chester. After supper visit the Scalecide Demonstration Plot, returning to West Chester at 8 p. m. The Fruit-growers Association of Chester County have invited the visiting entomologists to an informal gathering and smoker, for the rest of the evening.

JULY 17, THURSDAY

Leave West Chester at 8 a. m., daylight time, arriving at the Wilmington-Pennsgrove Ferry, at 10 a. m. Cross ferry, proceed from Pennsgrove to Glassboro or Bridgeton, N. J. Have lunch at either point, and proceed thence to Philadelphia. (It may be possible to make arrangements to stay over night at Bridgeton instead of returning to Philadelphia, although definite arrangements have not as yet been made). For the program on Thursday evening, arrangements have been made for Mr. J. L. King of the Japanese Beetle Laboratory to give an illustrated talk on his entomological experiences in Japan in connection with the Japanese beetle parasite work. This talk will be followed by a general discussion of the Japanese beetle project, and an informal discussion on any other points of common interest.

JULY 18, FRIDAY

Proceed Friday morning to Riverton, N. J. to spend the rest of the morning, (and as much additional time as individuals may desire) in looking over the Japanese

beetle work. Arrangements have been made for every facility to be given for inspecting the various phases of the Japanese beetle work at the Laboratory and in the field.

The program outlined above is definite as to its main points, although certain detailed arrangements are yet to be concluded. Before it is possible to definitely arrange for headquarters for Thursday night it will be necessary to have a general idea as to how many members will be present. Hotel accommodations for a large body of men in South Jersey are fairly limited.

Throughout the trip stops will be made at points where entomological projects are under way, such projects being conducted either under the direction of the Pennsylvania State College, or the Bureau of Plant Industry of the Pennsylvania Department of Agriculture, or the Bureau of Entomology of the Federal Department of Agriculture, or by these agencies in cooperation. It is planned to take in the field work in connection with the Japanese beetle, Oriental fruit moth, insecticide and fungicide tests being conducted under the general direction of the Crop Protection Institute, Angoumois grain moth, Greenhouse Insects, and general field projects on vegetable and fruit insects.

There is a lot of work of entomological interest being conducted in the district to be visited, and it is the hope of the committee that the meeting will be well attended and of interest and value to all.

Please note also that daylight saving time is used throughout the program above, since daylight time is in common usage in the districts to be visited.

For those who are not driving their own cars, provision will be made to find room for them in other cars, so that there will be room for all those who come whether they have their own machine or not.

Director C. H. Hadley, Bureau of Plant Industry, Harrisburg, Pa., wishes to be advised promptly, if this has not been done, as to the names of those attending, whether they plan to travel with their own cars and if so whom they plan to carry; also, indicate if there would be room for others. Suggestions as to individuals to whom notices should be sent would be welcome.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1924

The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $3.00 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded or the proof returned, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

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The Proceedings of the Horticultural Inspectors and those of the Apiary Inspectors not having come to hand in a reasonably complete form, it has been considered advisable to defer publication of that matter to a subsequent number. Several other papers would have been included in the present number if authors had supplied abstracts with the copy or upon request. Over four months have elapsed since the annual meeting and yet not all the copy has been received and some of the authors have been too busy to supply the required abstracts.

The urgency of immediate publication can hardly be sustained in the face of the above. Conditions sometimes arise which might lead to the conclusion that need of early publication does not develop until the paper is written. An editor, not necessarily a scientist, may sometimes arrive at the conclusion that years are to be devoted to leisurely preparation of a manuscript and only a few days allotted to its passing through the press. It is true that investigation may and should consume ample time for the reaching of trustworthy conclusions. There are cases, however, where the "rush" to get into print does not harmonize with the period of compilation. A real contribution to knowledge rarely suffers much from delayed publication, despite the general application of the law of priority.

ARTHUR LESTER LOVETT

Arthur Lester Lovett was born at Neal, Kansas, on August 25, 1885. He died April 25, 1924, at Corvallis, Oregon, from septicemia poisoning. He graduated from the Oklahoma Agricultural and Me-

chanical College in 1906 and acted as entomologist and state inspector for that institution until 1911. He came to the Oregon Agricultural College as instructor in entomology and assistant entomologist of the experiment station in the spring of 1911. In 1916 he was made head of the department of entomology with the title of associate professor, succeeding Professor Harley F. Wilson. In 1917 he was made professor. He is survived by his wife, a son, and a daughter.

A. L. Lovett in the short time of seventeen years had attained leadership in his chosen profession. He had a wide knowledge of the insects of economic importance in the Pacific Northwest and was constantly consulted by growers and professional workers without regard to state or national boundaries. His contributions to our knowledge of spraying and spray materials are well known and he had established his reputation as an authority on insecticides. He was a pioneer in the scientific investigation of the use of spreaders for insecticidal sprays. In spite of his pressing duties in economic entomology, he found time, until recently, to make contributions to systematic entomology, particularly on the Syrphidae. His published papers, both technical and popular are characterized by a clarity of style and aptness of expression that have made his contributions particularly valuable. The loss to economic entomology due to his mature experience is incalculable.

His eager interest to promote professional intercourse and co-operation among entomological workers was illustrated by his leading part in the inauguration of meetings of professional workers interested in the agriculture of the Northwestern states and British Columbia, which afterwards developed into the informal organization known as the Northwestern Association of Horticulturists, Entomologists and Plant Pathologists. His own fine generosity, modesty, and vision of professional service were largely instrumental in determining the practice of free interchange of unpublished information on entomological problems, which has characterized this organization from the first. His passing will leave a void in this fellowship.

While entomology has suffered a real loss in his untimely death, his associates and co-workers in the Pacific Northwest, in the United States and in Canada, will feel intimately the loss of his virile personality. The happy comradeship of road, hotel, and camp, where he never failed "to hold up his end" as a joyous companion, in work or in play, will be sadly missed.

G. A. Dean
R. C. Treherne
L. P. Rockwood

Current Notes

Entomological News for May announces the deaths of Herbert Campion, London, England, January 24, and of Dr. L. Peringuey, at Capetown, February 20, 1924.

Mr.R. T.Cotton of the Bureau of Entomology has recently been operated upon for appendicitis, and is now rapidly recovering.

Dr. T. L. Guyton has been elected Assistant Secretary of the new Pennsylvania Academy of Science, organized at Harrisburg, April 18.

Mr. E. A. Vaughan of the Bureau of Entomology has been transferred from Thomasville, Ga., to general grain investigations at Orlando, Fla.

On March 19, Prof. C. L. Metcalf delivered the Sigma Xi lecture for the Illinois chapter on the subject "Methods of Warfare Against Insects."

Mr. J. R. Horton of the Bureau of Entomology was at Manhattan, Kansas, on April 3, for a conference with the Entomologists of the Kansas Experiment Station.

Miss Evelyn Wells and Mr. John Bailey, advanced students of the University of Tennessee, have accepted positions with the Department of Entomology, University of Tennessee.

Mr. Hushime Murayama is spending several weeks at the Division of Insects, U. S. National Museum, making drawings, chiefly of butterflies and moths, for the National Geographic Society.

Mr. C. C. Hamilton, Assistant Professor of Entomology in the University of Maryland, spent several days during March in the Entomological Laboratory at the Kansas State Agricultural College.

Mr. and Mrs. C. R. Cutright and their infant son, Holt, have returned to Wooster from Ohio State University, where Mr. Cutright has been pursuing experiments with subterranean aphids.

Mr. F. E. Whitehead, a graduate student of the Kansas State Agricultural College, has accepted a position as Extension Entomologist and Associate Professor of Entomology at the University of Idaho.

According to *Science*, Mr. Albert Hugh Jones, the English entomologist, who made important contributions to science while engaged in banking, has died at the age of 84 years.

Mr. Guy F. McLeod, Assistant Entomologist, New York Agricultural Experiment Station, Geneva, N. Y., has been appointed Assistant Professor of Extension Entomology at the Pennsylvania State College, State College, Pa.

Dr. William Barnes of Decatur, Ill., recently spent about three days in the Division of Insects, U. S. National Museum, consulting with Mr. Busck and examining types in the collection of Lepidoptera.

Mr. J. C. Bridwell, formerly of the Bureau of Entomology and recently continuing his work upon the classification of Bruchidae, has accepted a position at Columbia University as Lecturer in Extension Entomology.

Dr. James Zetek, in charge of the laboratory of the Bureau of Entomology at Ancon, Canal Zone, will shortly visit Washington for the purpose of discussing plans of future work at the station.

The periodical Cicada (*Tibicina septendecim*) *tredecim* race is due to appear in 35

counties of West and Middle Tennessee this year. This is brood 23 of the 13-year race of the periodical Cicada.

On February 22, 1924, the Degree of Doctor of Philosophy was conferred by George Washington University on Philip Luginbill, Entomologist in Charge of the Columbia, S. C., laboratory of the Bureau of Entomology.

Mr. G. F. Moznette, Bureau of Entomology, has nearly completed an extensive survey of the fruit culture of Cuba and the Isle of Pines for fruit flies in connection with plant quarantine regulations.

Mr. Arthur Finnamore has been promoted to District Insect Pest Inspector and will be stationed at St. John, N. B., as officer in charge of that port of importation for nursery stock and plant products.

Professors Herbert Osborn of Columbus, Ohio, C. R. Crosby of Cornell University, Ithaca, N. Y., and Dr. W. E. Britton of New Haven, Conn., were visitors at the Division of Insects, U. S. National Museum on April 28.

The Mexican Bean Beetle (*Epilachna corrupta* Muls.) has already appeared in several parts of the State of Tennessee this season and egg-masses have been taken. At present seventy counties are known to be infested with this pest.

There has been a very serious outbreak of the Strawberry Weevil (*Anthonomus signatus*) in four counties of Tennessee, Hamilton, Rhea, Roane and Gibson. Early strawberries have suffered from ten to sixty per cent from the infestation of this insect.

Prof. Herbert Osborn of the Ohio State University spent several days at the Kansas State Agricultural College while en route from California to his home. While at Manhattan, Prof. Osborn addressed the Science Club on "Insect Relationship to the Environment."

On March 6, Dr. H. E. Burke of the Bureau of Entomology lectured before the Zoological Club of Stanford University on "Fighting the Western Pine Beetle." The lecture was illustrated by the Department moving picture of the same title.

Dr. L. O. Howard, Chief of the Bureau of Entomology, will be Chairman of the conference considering the questions relating to food production and conservation at the Pan-Pacific Congress to be held at Honolulu, July 21 to August 14, 1924.

Dr. Albert Hartzell, who has been engaged in research work on sulphur as an insecticide for the Crop Protection Institute and located at the Agricultural Experiment Station, Geneva, N. Y., has recently been appointed Entomologist of the Boyce Thompson Institute for Plant Research, Inc., at Yonkers, N. Y.

Mr. L. R. Cagle, fellow, Department of Entomology, University of Tennessee, has recently accepted a position with Prof. W. J. Schoene, Blacksburg, Va. Mr. Cagle will pursue the work on the life history of the Oriental Peach Moth, being stationed at Leesburg, Va.

Entomological News records the death of Colonel Charles Swinhoe, Lepidopterist, at Avonmore, West Kensington, London, December 2, 1923, and of the Reverend Canon Theodore Wood, son of Reverend J. G. Wood, and author of various entomological papers, at Wordsworth Common, England, December 13, 1923.

According to *Science*, Mr. J. L. King, who recently returned from Japan after three years study of the parasites of the green Japanese beetle, is now appointed as specialist in charge of the division of parasites at the Japanese Beetle Laboratory, Riverton, N. J.

Mr. C. P. Clausen, in charge of the Japanese Beetle parasitic work in the Orient, who has been in Washington for a temporary period, sailed from San Francisco March 4, for Kobe, Japan, to resume his field operations in connection with parasites for the Japanese beetle.

Dr. E. A. Back of the Bureau of Entomology was subpoened to appear on February 18 and 19 as a witness in the Superior Court of Baltimore in connection with an explosion occurring on board a grain boat during August, 1923, following the application of carbon disulphide.

The U. S. National Museum has recently received 79 specimens of Palearctic cynipids in exchange with the Zoological Museum, Vienna, Austria. This exchange has been arranged through the activities of L. H. Weld and the kindness of Dr. Franz Maidl. Most of the material comes from the Mayr collection.

Dr. F. A. Fenton of the Iowa Agricultural Experiment Station, Ames, has been engaged to take charge of the boll weevil laboratory at Florence, S. C., conducted by the Bureau of Entomology, in co-operation with the South Carolina Experiment Station. Dr. Fenton was to enter upon his duties May 1.

A collection of 84 species of Orthoptera of western Canada, collected by Mr. E. R. Buckell, was recently forwarded to the Imperial Bureau of Entomology by the Dominion Entomologist. It is of interest to state that 39 of these species were not represented in the British Museum Collection.

New species of mosquitoes from the United States, especially from the region east of the Rocky Mountains, are very rare. The Museum has recently received specimens of a new form from Brownsville, Tex. This furnishes the first new species east of the Rocky Mountains since the publication of the monograph on Culicidae in 1917.

Mr. B. Preston Clark has recently forwarded to Mr. Schaus 10,000 specimens of Lepidoptera from the Philippines; 6,000 of these specimens represent butterflies and the remaining are moths. The material is being mounted and prepared for study and will ultimately be deposited in the collections of the U. S. National Museum.

Prof. R. W. Harned of Mississippi, Drs. Wilmon Newell and J. H. Montgomery of Florida, Otto Brown of Alabama, W. J. Schoene and T. C. Johnson of Virginia, Dr. T. J. Headlee of New Jersey and Dr. Wm. Moore of New York, recently visited the Division of Truck Crop Insects of the Bureau of Entomology.

According to *Science*, an amendment to the Department of Agriculture appropriation bill has been submitted by Senator Harris of Georgia, to appropriate $100,000.00 "for the extermination and prevention of the cotton boll weevil, including an investigation of processes of the manufacture of calcium arsenate and other poisons" to be used in connection therewith.

Mr. and Mrs. L. L. Huber, who have been stationed at Wooster during the winter, left March 22 for Oak Harbor, which will be headquarters for the European corn borer laboratory this season. Mr. Huber is now moving the laboratory equipment from Geneva, Ohio, where the laboratory was located last summer, to Oak Harbor.

According to the *Official Record*, a shipment of European parasites of the alfalfa weevil for introduction into the infested area in this country was recently sent to the Salt Lake City laboratory of the Bureau of Entomology from the European Corn

Borer laboratory in France. A couple of years' observation may be necessary, however, before they are released in the weevil-infested area.

Dr. M. W. Blackman of Syracuse, N. Y., recently spent a week in the U. S. National Museum studying the collection of Scolytidae. Dr. Blackman has previously had certain members of this group for study and is devoting a good bit of his time to an examination of the field and rearing notes concerning these species.

According to *Science*, Dr. Anton A. Dampf, director of the Zoological Institute of Königsberg, has received a call from the Agricultural College of Mexico City to take over the post of Professor of Applied Zoology and State Entomologist. Dr. Dampf was formerly on the staff of the colonial government of German East Africa.

Mr. N. F. Howard, Entomologist in charge of the Birmingham, Ala., laboratory of the Bureau of Entomology, visited Ohio during the early part of February and attended the Farmers' Week held by the Ohio State University at Columbus. He presented a paper on the Mexican bean beetle and discussed the proposed work in that State.

According to *Science*, the Department of Entomology at the University of Kansas has been reorganized, with Dr. H. B. Hungerford as head and also as State Entomologist for the southern half of the state. Other members of the Department are: Dr. Paul B. Lawson, Mr. Philip A. Readio, Mr. R. H. Beamer and Miss Kathleen Doering.

According to *Science*, Mr. Frank L. Thomas, acting entomologist of the Alabama Experiment Station, has been appointed chief entomologist of the Experiment Station and State Entomologist of Texas, the appointment becoming effective on May 1. He succeeds Dr. M. C. Tanquary, who has resigned in order to engage in commercial beekeeping with headquarters in Fargo, N. D.

Dr. H. G. Dyar has left for a three months' trip to the West Coast to study and collect mosquitoes. There are a few species occurring in the Western States which are unknown in the larval stages, and Dr. Dyar is very anxious to obtain notes on the habits and also a complete set of the immature stages.

Dr. G. C. Crampton of the Massachusetts Agricultural College was in the U. S. National Museum on March 10 and 11 consulting with various specialists in regard to some of his problems on insect anatomy. He also spent some time in the Division of Invertebrate Zoology consulting with Dr. Waldo L. Schmitt on some of the forms of Crustacea.

A recent conference was held in Philadelphia for the purpose of discussing all phases of the Japanese beetle project, including quarantine operations. Those present were Drs. T. J. Headlee and A. L. Quaintance, Messrs. L. B. Smith, C. H. Hadley, E. R. Sasscer, B. R. Leach, C. W. Stockwell, C. A. Thomas, E. R. Van Leeuwen, W. E. Fleming, G. B. Stichter, T. H. Worsinger, and Prof. C. A. McCue.

Prof. Geo. A. Dean of the Bureau of Entomology, visited the Columbia, S. C., laboratory March 26, the Department of Entomology of the North Carolina State College March 28. Since then he has traveled to Ohio, Iowa, Utah, Lawrence, Kan., and Webster Groves, Mo., to look after the work of his Division in the investigations of Cereal and Forage Crop Insects.

Mr. C. R. Neiswander, who has been pursuing anatomical and morphological studies with the larvae of the European corn borer at Ohio State University during

the past winter, spent the last week in March at Wooster in preparation for the summer's work. He and Mrs. Neiswander have joined the Hubers at Oak Harbor, where he will assist with field studies of the corn borer.

Mr. O. G. Babcock of the Bureau of Entomology left by automobile from his field station at Sonora, Tex., on April 17 for Carlsbad, N. Mex., where he will spend several days working with Mr. Vernon Bailey on an insect survey of the Carlsbad Cave. This is one of the largest caves in the world and will probably yield some interesting insect material.

Mr. Carl Heinrich of the U. S. National Museum left Washington early in March for a month's trip to study types of Microlepidoptera and to consult various specialists. He planned to visit the American Museum of Natural History, the Museum of Comparative Zoology, the National Museum of Canada, and the collections of Dr. Wm. Barnes, Decatur, Ill., and Miss Annette F. Braun, Cincinnati, Ohio.

The collections of Coleoptera and Lepidoptera made by the late Thomas G. Bishop, of Dalmore, Helensburg, have been given by his son, Mr. A. Henderson Bishop, to the University of Glasgow for its new Zoological Museum. This collection is contained in 18 cabinets enclosing 700 separate boxes, and numbers some thirty or forty thousand specimens, all beautifully mounted, labeled, systematically arranged and in perfect condition.

Dr. E. A. Back of the Bureau of Entomology read a paper on the effect of cold storage on insects before the 13th Annual Convention of the American Association of Ice and Refrigeration at the New Willard Hotel, Washington, D. C., in the latter part of March. Dr. Back went to New York April 8 to inform himself regarding development of certain so-called mothproofing treatments now being advertised rather extensively.

The Division of Insects, U. S. National Museum, has received for study a third shipment of types of American muscoid flies loaned by the Zoological Museum in Vienna, Austria. This material is a part of that which was the basis of Brauer and Bergenstamm's large work published some 30 years ago. The classification of the material in the National Museum will be very much improved by the study of these types.

Mr. A. E. Miller, who had been pursuing studies of Ohio mites at the National Museum, Washington, D. C., during the winter, has returned to the Field Laboratory at Chillicothe. He was at Wooster the last week in March for laboratory equipment. One of his major projects this year will be with the Mexican bean beetle. He determined while at Washington that he has many new species of mites in his Ohio collection.

Dr. Herbert Osborn, Research Professor, Ohio State University, delivered a series of four lectures in the University of Illinois, April 9 to 11 on the following subjects: (a) The Relation of Insects to Their Environment; (b) Entomological Explorations; (c) Opportunities and Qualifications for Entomological Work, and (d) Entomological Pioneers. On the evening of April 10, a dinner was given in his honor at which about 35 students and faculty members were present.

According to *Science*, Dr. W. M. Wheeler of the Bussey Institution, of Harvard University, was the guest of the Zoologists of Indiana University from December 10 to 12. He lectured before the chapter of Sigma Xi on "Bergson's Attitude Toward

Instincts," and before the convocation of the whole University on "Ants." These are the first public lectures in entomology to be given at Indiana University since the recent establishment of courses in entomology there.

An outbreak of the destructive spruce bark-beetle is apparently developing in Newfoundland. Infested logs and an account of the injury sent by the Newfoundland Department of Agriculture and by one of the lumber companies makes it certain that the species is at least abundant. Information which is expected to be received shortly will determine how extensive the outbreak has become and to what extent control measures will need to be applied.

The U. S. National Museum has recently received its first lot of Diptera from Greenland. This material was received as an exchange from the Zoological Museum in Denmark, and represents 80 of the named flies from this island. Flies are the most abundant insects in the Far North, the order Diptera being represented in Greenland by 188 species, while the Coleoptera are represented by 41, the Hymenoptera by 66, the Lepidoptera by 46, and Hemiptera by 12.

On March 3, 4 and 5, Mr. J. C. Evenden of the Forest Insect Field Station of the Bureau of Entomology, Coeur d'Alene, Idaho, gave a series of five illustrated lectures on Forest entomology to the forestry students at the University of Idaho, Moscow, Idaho. On March 10 and 11, Mr. Evenden attended the quarterly meeting of the North Idaho Forestry Association at Spokane, Wash. At this meeting considerable time was given to an informal discussion of forest insect problems.

According to *Science*, Prof. W. B. Herms, of the University of California, left San Francisco on the motor schooner "Doris Crane" on April 10, for Fanning Island, where he will study cocoanut pests. While in the South Seas, Prof. Herms will also carry out a general survey of the fauna and flora of Fanning and other neighboring islands. Mr. Harold Kirby, fellow in zoology, will assist in the work. The investigation will extend over a period of about four months.

Mr. H. G. Crawford, Entomological Branch, Canadian Department of Agriculture, attended a conference at Niagara Falls, Ont., on March 10, in connection with the investigations in the control of the European Corn Borer. Prof. G. A. Dean, D. J. Caffrey, H. N. Bartley, F. W. Poos and Prof. L. Caesar were in attendance. The U. S. officials had recently held a conference at Columbus, Ohio, with the Ohio State officials; the meeting at Niagara Falls reviewed fully the plans for next summer's operations in Canada and the United States.

Mr. William Fletcher Harding, Editor in the Bureau of Entomology, died of pneumonia, March 1, 1924, after only a few days' absence from his duties. Mr. Harding was born in Indianapolis, Ind., September 2, 1868, and graduated from the University of Indiana. He also received a master's degree from the University of Chicago. He entered the U. S. Department of Agriculture in 1903 as an editorial clerk in the Division of Publications and in 1922 was transferred to the Bureau of Entomology as Associate Editor.

Mr. N. G. Wessels, a student of the Government of the Union of South Africa, spent several weeks during January and February visiting the Bureau of Entomology laboratories at Dallas, Uvalde, and Sonora, Tex., in connection with his study of Angora goat production in this country. He also spent a few days in Washington just prior to sailing for England. Mr. Wessels is a student of Dr. R. O. Wohl who is

entomologist at the Grootfontein School of Agriculture, Middleburg, Cape, and visited this country some two years ago.

Recent appointments in the Bureau of Entomology are announced as follows: W. B. Wheelis, junior entomologist in research investigation on the Mexican bean beetle, Alfred Lutkin, agent in eradication of sweet potato weevil in southern Mississippi in co-operation with State Plant Board; Robert M. Fouts, field assistant, pecan insect investigations, Brownwood, Tex.; Travis E. McNeel, junior entomologist, malaria mosquito investigations, Mound, La.; W. D. Mecum, temporary field assistant, Madison, Wis.; L. W. Brannon, Mexican bean beetle laboratory, Birmingham, Ala.; P. R. Hickborn, pea aphis investigations, San Jose Valley, Calif.; F. A. Fenton, boll weevil laboratory, Florence, S. C.

An important conference was held at Tucson, Ariz., on April 10 to determine the best procedure to follow in view of the recent discovery of the Thurberia weevil in cotton grown near Tucson. It was attended by the Arizona Quarantine Commission, representatives of cotton planting interests in Arizona, and by W. D. Hunter, R. E. McDonald of the State Department of Agriculture, as well as A. W. Morrill and W. D. Pierce. The State Commission decided, on the advice of W. D. Hunter and R. E. McDonald, to establish a non-cotton zone extending about 30 miles from the Santa Catalina Mountains.

Dr. W. R. Dodson, Chairman of the Cotton Council of the Association of Southern Agricultural Workers, called a meeting at Atlanta, Ga., on April 14, for considering plans to use as nearly as possible a uniform system in planning and recording boll weevil experiments during the coming season. Such a course is highly desirable on account of the difficulty which has been experienced heretofore in comparing results obtained in experiments performed according to diverse plans. Entomologists from practically all of the Southern States except North Carolina and Florida were present. Mr. B. R. Coad represented the Bureau of Entomology. A definite program was worked out and adopted.

A conference of the entomologists of Ohio, especially those dealing with the corn borer problem, the county agricultural agents of the quarantine counties, and the editors of daily and weekly papers in the quarantined area, met at the offices of the *Ohio Farmer*, April 4, for the purpose of enlisting and co-ordinating the efforts of all these men and agencies to clean up effectually and destroy all the corn borer larvae possible this spring. The clean-up campaign is under the direction of T. H. Parks, extension entomologist, of Ohio State University. H. A. Gossard, J. S. Houser, L.L. Huber, and C. R. Neiswander attended the conference and will participate in the activities of clean-up week.

According to *Science*, on the afternoon of April 3, Prof. John Henry Comstock of Cornell gave an address on "Early Entomologists and Their Work" in the lecture room of the department of entomology of Stanford University. The lecture was attended by a number of professors and students of the University of California and of Stanford University, and by some of the entomologists of the California Academy of Sciences and others of the San Francisco Bay region. In the evening a dinner was given at the Stanford Union in honor of Professor and Mrs. Comstock. After the dinner, Professor and Mrs. Comstock both gave interesting talks. Dr. David Starr Jordan, chancellor emeritus of Stanford University, one of Dr. Comstock's first students in entomology, and others also gave very interesting talks.

On April 21 Dr. E. A. Schwarz was eighty years old. To celebrate his birthday and to show appreciation for his kindnesses the ladies of the Division of Insects, U. S. National Museum, gave him a magnificent bunch of roses with appropriate greetings. The same evening a dinner attended by 26 people was given in his honor at the Cosmos Club, at which Dr. Howard acted as toastmaster. Speeches were made by Dr. B. Pickman Mann, Dr. C. W. Stiles, Dr. E. D. Ball, Dr. J. M. Aldrich and others. All the speakers pointed out the value of Dr. Schwarz's services to the science of entomology, recalling instances that occurred during his past life. All expressed the opinion that the most important reason that Dr. Schwarz had so many friends was because he had always been willing to help others and had taken so much interest in the work of younger men. To these addresses Dr. Schwarz replied in his characteristic modest manner. The April number of the Proceedings of the Entomological Society of Washington was issued on April 21 with an appropriate editorial about Dr. Schwarz, and at the regular meeting on May 1, Dr. Howard gave a brief talk and exhibited a dozen lantern slides showing pictures of Dr. Schwarz taken at various times since his connection with the U. S. Department of Agriculture.

Notes on Horticultural Inspection

Mr. J. H. Moreland was recently transferred from Dr. Hunter's force to take up inspection work at Laredo, Texas.

Dr. Marlatt and Mr. L. A. Strong are attending a meeting of the Western Plant Quarantine Board at Denver, Colorado.

Mr. V. J. Shimer has been appointed Plant Quarantine Inspector in Charge at the port of Laredo, Texas, where he succeeds Mr. Edgar S. Jewell.

The Avocado Weevil has been collected several times in Avocado fruits taken from passengers coming across the Border at the ports of Brownsville, Laredo, Del Rio, Eagle Pass, and El Paso.

Mr. L. J. Bottomer and Mr. P. A. Hoidale, both of Dr. Hunter's force connected with the Pink Bollworm Eradication work in Texas, have been in Washington for several weeks, helping with the nursery inspection work during the rush season.

Mr. E. R. Sasscer recently made a trip to the Mexican Border for the purpose of consulting with the inspectors in charge of the various ports. Mr. Deputy, Chief Inspector, Border Inspection, joined Mr. Sasscer at Laredo, and accompanied him on the trip along the Border.

The Report of the Committee on Crown Gall Inspection, which was submitted to the American Phytopathological Society on December 31, 1923, and to the American Association of Economic Entomologists on January 1, 1924 at Cincinnati, Ohio, was adopted unanimously by the two organizations. The Report has now been published and has been distributed to the inspectors at all of the ports of entry.

A shipment of about two bushels of cotton in bolls, which was sent to this country for the purpose of testing ginning machinery, was intercepted at New York and a sample taken and sent to Washington. An examination of this sample resulted in collecting dead larvae of a lepidopterous insect, *Earias fabia* Stoll. This insect is known to be a serious pest of cotton in India and is a rival of the Pink Bollworm in the amount of damage caused to the cotton crop.

Quarantine Conference

A three day conference of State and Federal Nursery Inspection Officials was held in Washington from April 28th to 30th. The purpose of the meeting was to arrive at a clear understanding of the limitations of State and Federal Quarantine powers with the object in view of securing the best possible co-operation in placing and enforcing the necessary Quarantines. In preparation for the conference, a summary of the State Quarantines and regulations pertaining to the movement of Nursery Stock was prepared. The recommendations of the Plant Quarantine conference as approved by the representatives from the various States were drawn up for presentation at the meeting of the Western Plant Quarantine Board. The following entomologists and inspection officers represented their respective States: Alabama, O. Brown; Arkansas, Geo. G. Becker; California, Lee A. Strong; Connecticut, W. E. Britton; Florida, Wilmon Newell, F. M. O'Bryne, J. H. Montgomery and O. T. Stone; Georgia, Jeff Chaffin; Indiana, Frank N. Wallace; Maryland, Ernest N. Cory, Geo. S. Langford, S. F. Potts, P. D. Sanders, T. B. Symonds and A. F. Woods; Massachusetts, R. H. Allen; Michigan, L. R. Taft; Mississippi, R. W. Harned, Hunter H. Kimball; New Hampshire, W. C. O'Kane; New Jersey, Thomas J. Headlee; New York, Geo. G. Atwood, C. R. Crosby; North Carolina, T. B. Mitchell; Ohio, Richard Faxon; Pennsylvania, C. H. Hadley; South Carolina, A. F. Conradi; Virginia, W. J. Schoene, T. C. Johnson; West Virginia, W. E. Rumsey; Wisconsin, L. R. Jones. The Federal Horticultural Board was represented by C. L. Marlatt, W. A. Orton, H. F. Kellerman, Geo. B. Sudworth, E. R. Sasscer, L. A. Strong, R. K. Beattie, David Lumsden, R. C. Althouse. The Bureau of Entomology was represented by A. L. Quaintance, W. R. Walton, A. F. Burgess, D. M. Rogers, L. H. Worthley, H. L. Blaisdell, C. W. Stockwell, Loren B. Smith, Harold Morrison and F. G. Robb. The conference was addressed by Secretary Henry C. Wallace and by Thomas G. Shearman, Assistant Solicitor. Professor W. C. O'Kane was elected Chairman of the conference and R. C. Althouse, Secretary. A committee was appointed to prepare recommendations in the form of a report to be submitted to the conference before adjournment. The personnel of the committee was as follows: W. C. O'Kane, Chairman, W. E. Britton, Wilmon Newell, Frank N. Wallace, Lee A. Strong, C. L. Marlatt, W. A. Orton, Geo. B. Sudworth and H. F. Kellerman. This committee reported as follows:

The Basis of Agreement: In this conference of State and Federal officials concerned in the promulgation and enforcement of plant quarantines established for the prevention of spread of plant pests and for their control or eradication, it is recognized that we have a common purpose, that the State and Federal powers are complementary, and that both are essential for such control. The principal purpose of the conference, therefore, is to secure full co-operation and to eliminate conflicting action. With this in view, it is the sense of this conference that such full co-operation on the part of the State and Federal plant quarantine officials shall be mutually accorded and accepted in all procedure both with reference to the readjustment of existing State and Federal plant quarantines and their enforcement and with regard to the promulgation of future plant quarantines.

Scope of Quarantine Action: Recognizing that plant quarantines are often the only feasible means of preventing the entry or controlling the spread of diseases and insect pests, it is nevertheless obvious that such quarantines should be established only when the economic benefit to a region, State or country clearly outweighs the

inconvenience, expense, and loss that such quarantines may occasion. Such quarantines may be divided into the following classes: First, restrictive quarantines. These should be employed whenever their action will sufficiently accomplish the purpose sought. Restrictive quarantines are believed to be sufficient for the following subjects: (a) Where adequate safeguards by inspection and treatment are believed to be feasible. (b) For diseases or pests of long establishment or of wide distribution, where retardation of spread is believed to be the only object that is practicable of accomplishment. (c) For diseases or pests of minor economic significance which can be at least partially controlled by inspection without heavy expenditure and without entailing heavy losses. Second, embargoes. These should be employed only where restrictive quarantines are inadequate. The employment of an embargo may be justified in cases where the infection or infestation is of such types as: (a) The presence of which can not with reasonable certainty always be determined by inspection; for example, white pine blister rust, citrus canker, Oriental peach moth, and satin moth; (b) Where the volume or nature of the material involved makes efficient inspection economically impracticable; for example, the inspection of hay for the presence of alfalfa weevil; (c) Where adequate inspection at point of origin is not maintained and there remains risk or danger of escape of injurious insects or the establishment of a plant disease either in transit or at destination regardless of inspection at destination; for example, shipments infested with the Mexican bean beetle; (d) Where the elimination of host plants for the purpose of eradication or control of a disease or pest is under way in a region and these plants whether attacked or not may jeopardize the eradication or control activities.

CORRELATION OF STATE AND FEDERAL ACTION: It is the sense of this conference that all State quarantines should be so limited in subject and scope as not to conflict with existing Federal quarantines, and that all State quarantines now in force which are in conflict with such Federal quarantines should be modified so as to eliminate such conflict. It is further understood that, in any case where it is considered inexpedient for the Federal quarantine to cover the entire subject necessary for the protection of a State, any additional protection which the State may need is understood to be left open for State action. If such State action is taken it is understood that it should be supplemental to, but not in conflict with, the action taken under the Federal quarantine. It is understood and agreed that the needs of a State with respect to any plant quarantine subject may be presented to the Federal Horticultural Board at any time, but preferably at the original or other stated hearing, and that so far as the Federal Horticultural Board shall deem such incorporation practicable after full discussion and consideration with the State authorities, such needs shall be incorporated in the Federal regulations. *Example:* This may include provision for so routing movement within a State as to provide for reinspection by State officials at designated concentration points somewhat on the plan of the postal provision for such routing and inspection of parcel post packages of plants. It is also understood that with respect to any subject on which the Federal Horticultural Board has not acted the State may act. It is recommended also that where existing State legislation is inadequate to secure full co-operation between State and Federal authorities and to enable State authority to be conferred upon Federal inspectors an attempt shall be made to obtain enabling legislation. As a knowledge of the final destination of plants is a very important factor in the control of plant pests it is the sense of this conference that the Federal Horticultural Board should promptly send notice to the proper au-

thorities of the State of destination, whenever requested to do so, as to every shipment of plants from an area under Federal quarantine, giving the name and address of both the consignor and the consignee, and the number and kind of plants included in the shipment.

NOTIFICATION BY A STATE OF PROPOSED ACTION: A State considering the issuance of a quarantine or other regulation of interest to another State shall send notice, as far in advance as practicable, to the Federal Horticultural Board, to plant quarantine officers of other States, and to others in interest.

NOTIFICATION BY A STATE OF ACTION TAKEN: In case a State enacts legislation or issues a quarantine or other regulation or modification of existing regulations, whether referring to interstate or to intrastate movements copies of the new or amended measure shall be sent immediately to the Federal Horticultural Board, to plant quarantine officers of other States, and to others in interest.

NOTIFICATION OF CHANGES IN PERSONNEL: The Federal Horticultural Board and plant quarantine officers of all States should be kept notified of all changes in responsible plant quarantine officers.

APICULTURAL NOTES

Mr. George H. Rea assisted Prof. G. M. Bentley in a series of beekeeping meetings in Tennessee during the month of April.

A meeting of the Maine State Beekeepers' Association was announced for April 2, at the University of Maine. Mr. Geo. Yeaton is Secretary.

Dr. E. F. Phillips and A. P. Sturtevant of the Bureau of Entomology recently made a short trip to New York State in connection with work on bee diseases.

Mr. E. L. Sechrist of the Bureau of Entomology attended a series of annual meetings of the State Beekeepers' Association in Tennessee, Arkansas and Missouri, beginning on February 1.

Dr. A. P. Sturtevant of the Bureau of Entomology will go to Wyoming early in June for the purpose of investigating the sacbrood of the northern part of the state, which is often serious.

An appropriation has been made to the New York State College of Agriculture for a professorship of Apiculture and provisions have also been made for the continuation of the extension work in beekeeping.

At the annual meeting of the Connecticut Beekeepers' Association held at Hartford, April 26, the following officers were elected: President, Allen Latham, Norwichtown; Vice-President, J. D. Kroha, Danbury; Secretary-Treasurer, C. H. Rost, Meriden.

Mr. J. I. Hambleton of the Bureau of Entomology attended the two series of meetings held by the University of Illinois, one at Carbondale February 20 and 21 and the next at DeKalb February 22 and 23.

A short course in beekeeping, May 13-16, has been announced by the Division of Bee Culture of the University of Minnesota. This course is in charge of Professor Francis Jager and given at University Farm, St. Paul, Minn.

Mr. J. H. Heatherly, State Apiarist of Tennessee, has resigned on account of ill health and Mr. W. L. Walling of Knoxville has been appointed in his place. Mr.

Walling will work under the supervision of the State Entomologist, Prof. G. M. Bentley.

Recent visitors to the Bee Culture Laboratory of the Bureau of Entomology were: Prof. N. E. Phillips, Extension Apiarist, and D. L. Van Dine, Extension Entomologist, both from State College, Pa. Dr. E. Kohn of Grover Hill, Ohio, and Dr. L. D. Leonard of Minneapolis, Minn., both prominent beekeepers, also visited the laboratory.

Dr. E. F. Phillips attended the annual meeting of the Ohio State Beekeepers' Association held at the Ohio State University, Columbus, on February 7 and 8, and the following week attended a special series of meetings for beekeepers held by Purdue University, Lafayette, Ind. While in Lafayette, Dr. Phillips spoke before the monthly meeting of the extension staff of the University.

The importance of the winter packing of bees is emphatically shown by the condition of the bees in Tennessee this spring. Those who packed allowing proper amount of stores for their colonies already have eight frames of brood. Those who did not direct attention to packing, although with plenty of stores, have come through in a weakened condition.

Messrs. Lloyd M. Bertholf and Bruce Lineburg, who were employed at the Bee Culture Laboratory of the Bureau of Entomology last summer, will return there for work about June 1 for the summer period. Mr. Carlton Burnside, a graduate of the University of Michigan, will also be at the laboratory to investigate the fungi of the alimentary tract of the adult bee.

According to *Gleanings in Bee Culture*, Mr. Warren Whitcomb, a senior in agriculture at the University of New Hampshire, is making a survey of the beekeeping industry of New Hampshire with special reference to the kinds and amount of honey produced and the disease conditions. Mr. Whitcomb will give particular attention to the eradication of brood diseases as New Hampshire has no foul brood law, and consequently is not permitted to send bees into neighboring states.

Prof. R. B. Willson, Extension Specialist in Apiculture at Cornell University, Ithaca, N. Y., gave a radio talk on "The Uses of Honey" from Station WEAF, New York City, on February 27, and on account of it received 372 requests for the Government Bulletin, "Honey and its Uses in the Home." Prof. Willson in company with some of the New York apiary inspectors, planned to visit Medina and Ashtabula, Ohio, early in April, to study, first hand, the problems connected with the sterilization of diseased combs by the alcohol-formalin method.

Plans for the VII International Apicultural Congress are progressing satisfactorily and the final program will be issued about June 1. Information regarding the details of the Congress may be obtained from M. C. Vaillancourt, Ministéré de Agriculture, Quebec, who has charge of the arrangements. The proceedings of the Congress will be held in both French and English and all papers submitted will be translated so that they may be read in both languages. Following the meetings of the Congress, to be held September 1-4, several interesting excursions are arranged for those in attendance, including one to the Saguenay River on a specially chartered boat.

NOTES ON MEDICAL ENTOMOLOGY

Prof. G. M. Bentley gave a talk on *Hypoderma lineata* before the Agricultural Club of the University of Tennessee on April 30, accompanying his talk with U. S. motion picture reel on this insect.

A number of cities in the Southwest are beginning active campaigns against mosquito breeding places with a view to preventing a recurrence of the dengue epidemic, and also to reduce malaria incidence as well as eliminate annoyance from mosquitoes.

Mr. William A. Hoffman from the School of Public Health, Johns Hopkins University, recently spent several days at the U. S. National Museum in studying blood-sucking flies. Mr. Hoffman was especially interested in members of the genus Culicoides and related forms.

Mr. W. E. Dove, who was formerly connected with the office of the Bureau of Entomology dealing with insects affecting live stock has been reappointed and is to devote the major part of his time to investigations of the cattle grub, screw worm and horse flies. His headquarters will be Dallas, Texas.

About the middle of May, Dr. Roark of the Bureau of Chemistry reached Dallas where he is to work co-operatively with the agents of the Bureau of Entomology on the problem of developing satisfactory repellents for the screw worm and related blow flies. Considerable time is to be spent on ranches in the vicinity of Uvalde, Texas, in the actual treatment of screw worm cases.

The Bureau of Entomology recently received for identification a larva of *Hypoderma lineatum* Vill., from the Parshall, N. D., Public Health Laboratory, sent in by Dr. P. B. Carter, who stated that it had been taken from the elbow of a little girl five years of age. It had burrowed under the skin across the child's back. This maggot normally lives in cattle, burrowing into the skin in the same way.

Prof. F. M. Root, of the School of Public Health, Johns Hopkins University, spent a day in the U. S. National Museum consulting with Mr. Greene on characters of muscoid larvae. Dr. Root has recently published a short paper setting forth some of the characters of these larvae, and Mr. Greene has also spent considerable time on members of the same group. Dr. Root was also interested in the South American fleas and mosquitoes.

Mr. Eric Hearle of the Vernon, B. C., Laboratory, Entomological Branch, Canadian Department of Agriculture, visited Kelowna on February 8 and 9 in connection with mosquito control work as a result of a request from the local committee in charge. Arrangements have been completed for continuing the control work in the Banff district. Mr. Hearle reports that the season is greatly advanced and the weather milder than has occurred during the same period for seventeen years.

ECONOMIC ENTOMOLOGY AND PHYTOPATHOLOGY

It will be recalled that Dr. L. O. Howard, in his report as Delegate to the International Conference of Phytopathologists and Economic Entomologists held in Holland last June, see pages 9–14 of the February issue, included some correspondence relative to the European use of the word phytopathology as comprehending insect depredations as well as plant diseases. Through the Secretary of Agriculture, the matter was brought before the International Institute at Rome.

The following communication is self explanatory:

INSTITUT INTERNATIONAL
D'AGRICULTURE

LE DÉLÉGUÉ
DES ÉTATS-UNIS-D'AMÉRIQUE

ROME, May 17, 1924.

Dr. L. O. Howard, Chief, Bureau of Entomology,
U. S. Department of Agriculture, Washington, D. C.

DEAR DR. HOWARD:

Your proposal to change the name of the 3rd Bureau of the International Institute of Agriculture from Bureau of Agricultural Information and Plant Diseases to Bureau of Agricultural Information and Plant Protection was submitted to the General Assembly for consideration.

After discussion it was decided that both the present name and the proposed title were rather long and that the word "information" was too indefinite as an indication of the activities of the Bureau. Hence, the name of the Bureau was changed to the shorter title of "Bureau of Agricultural Science."

The complete resolution as passed is as follows:

"The 3rd Bureau shall in future be called in French 'Bureau de Reseignements Agricoles' and in English 'Bureau of Agricultural Science'."

I hope that this change fully meets the objections raised by you against the old name.

Yours truly,
ASHER HOBSON,
Delegate of the United States

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VOL. 17 AUGUST, 1924 No. 4

Proceedings of the Thirty-sixth Annual Meeting of the American Association of Economic Entomologists
(Continued)

Section of Horticultural Inspection
(Saturday, December 29, 1923)

The meeting of the Section of Horticultural Inspection convened at 1:30 P. M. with Chairman P. A. Glenn presiding. After a few preliminary remarks and the appointment of a nominating committee, the Chairman called for the motion picture entitled "Halting Foreign Plant Foes." This picture illustrated some of the most important activities of the Federal Horticultural Board, laying special emphasis on the inspection and fumigation work conducted at various maritime and border ports of entry.

RECENT WORK OF THE FEDERAL HORTICULTURAL BOARD

By C. L. Marlatt
(Abstract)

A brief review was given of the more important activities of the Federal Horticultural Board during the calendar year 1923. Reference was made to several important conferences held in Washington and elsewhere. Recent changes in the Board's organization were mentioned, and followed by a short discussion of the finding of the Mediterranean Fruit Fly in Almeria grapes arriving at the ports of New York, Boston, and Philadelphia, from Spain.

HORTICULTURAL INSPECTION METHODS IN CALIFORNIA

By Lee A. Strong
(Abstract)

A brief, general discussion was given of the work performed by the Bureau of Plant Quarantine and Pest Control in California. Various

phases of the inspection work of that state were treated, including the examination performed at San Francisco and other ports of entry for the purpose of intercepting injurious insects and plant diseases which may arrive in shipments, or in ships' stores or passengers baggage, the inspection and certification of nursery stock, inspection of incoming domestic material at the freight and express offices and the Post Office.

THE FIGHT AGAINST THE GIPSY MOTH IN NEW JERSEY

By THOMAS J. HEADLEE, *State Entomologist*

ABSTRACT

The eight hundred and fifty-five gipsy moth (*Porthetria dispar* Linn.) colonies in New Jersey in 1920–1921 were reduced to two hundred and sixteen in 1921–1922 and further reduced to ninety-eight in 1922–1923. Fifteen areas of slight infestation unconnected with the main area were apparently completely exterminated by the completion of the work in 1921–1922. Five hundred square miles of the original area of infestation has been reduced to about two hundred and fifty square miles. With the completion of the year 1922–1923 approximately $778,335.31 have been spent of which approximately one-half had been furnished by the state and private sources and one-half by the United States Department of Agriculture.

Infested shipments of nursery stock have been received from New England as follows:—In 1921–1922 twelve; in 1922–1923 fourteen; 1923–1924 (report to December 12, 1923) two. Ultimate success in gipsy moth work in New Jersey means, not only the extermination of the present infestation but, the prevention of reinfestation from any source whatsoever and, consequently, New Jersey has a vital interest in the prevention of the spread of the gipsy moth from the great infested area in the New England states.

At each of the three meetings of this society held previous to this one the writer has presented a statement of the warfare against the gipsy moth in New Jersey. Much of the detailed data which he presented in these papers has been superseded by statements based upon more complete information. The revised statistics are found in the 6th, 7th and 8th annual reports of the New Jersey State Department of Agriculture, which are listed as bulletins 29, 33 and 37 of that organization. Still further information of a detailed character can be found in circulars 38, 56 and 67, issued by the same organization. It is only fair to say, however, that the general tenor of the data submitted by the writer has not been changed by the obtaining of more complete information and that the conclusions reached by him stand firm.

If he were listening to a statement of this sort from another state he would want to know first the results obtained in this warfare and second what the warfare had cost. Because of the existence and availability of this detailed data to which the writer has referred and be-

cause he believes that your desire for information concerning the warfare against the gipsy moth in New Jersey is probably very similar to his own he will confine his statement of data to results and to expenditures.

TABLE NO. 1

Year	Size of main area in sq. miles	No. of colonies	No. of egg masses	No. of areas outside main area	No. of colonies	No. of egg masses	No. of gipsy moth infests found on imports untreated egg masses or larvae
1920-'21	500	855	3,003,039	15	6	40	
1921-'22	500	216	909	15	0	0	12
1922-'23	250	98	1,182	0	0	0	14
1923-'24*	25% scout'd	26	353	0	0	0	2

*Report to December 12, 1923.

Table No. 1 shows that in the course of the three completed years of warfare all outlying infestations of gipsy moth have been exterminated, that the original five hundred square mile area of scattered infestation has been cut to about two hundred and fifty square miles, that each year has seen a large reduction of the number of colonies within the main area and that the extermination of the insect within this area looks to be practicable.

This table also shows that a menace to the extermination of the gipsy moth in New Jersey exists in the form of infestations being brought into New Jersey on imported products. It happens that these products are exclusively, in the instances where the infestations have been found, composed of nursery stock.

TABLE NO. 2

Year	Total	Funds Federal	State	Private
1920-'21	259,495.04	122,495.04	112,000.00	25,000.00
1921-'22	226,572.61	101,672.61	125,000.00	
1922-'23	292,267.66	167,267.66	125,000.00	
1923-'24	?	?	125,000.00	

Table No. 2 serves to show the expenditures and the distribution of source among federal, state and private agencies. The sums recorded in this table are large, but the nature of the work of extermination is such apparently as to forbid the use of smaller sums.

The gipsy moth problem cannot safely be considered from the standpoint of one state alone. If it is granted that the gipsy moth may be exterminated in New Jersey there is absolute certainty of reinfestation unless other infestations from which gipsy moth may be carried into that state are considered and the problems involved in preventing this transportation of infestation met and solved.

The writer feels that it is fair to assume that infestation coming from foreign countries, either on this continent or elsewhere, will be prevented through the activities of the Federal Horticultural Board in cooperation with state agencies. This being the case, the gipsy moth problem then involves either the extermination of all infestations within the limits of the United States, or the extermination of part and the adequate prevention of the movement of infestation from the balance. As matters now stand it looks as if gipsy moth infestations outside of New England can and will be exterminated. It also looks as if extermination of Gipsy moth infestations within the New England States cannot be accomplished in a limited space of time, and that therefore exterminative work should be pursued in dealing with all infestations outside of the New England States and that movement of infested material from the New England States into other parts of the United States should be so restricted as absolutely to prevent the escape of infestation from that area into other parts of this country.

STATUS OF HYDROCYANIC ACID GAS TREATMENT OF NURSERY STOCK

By John J. Davis, *Purdue University, Lafayette, Ind.*

Abstract

Summarizes complaints from both nurserymen and from orchardmen relative to injury to nursery trees when fumigated with hydrocyanic acid gas and the factors involved. The need of further experiments with the gas and additional materials and probable plans for such investigations are suggested.

With the early recognition of the San Jose scale as an orchard pest of first-rate importance and the recognition of the nursery as the biggest factor in its spread to new localities, state laws were enacted in rapid succession. The discovery of the value of hydrocyanic acid gas as an effective agent against the scale and the comparative ease with which it could be used led to the almost universal adoption of this method of treating nursery stock.

We have all heard of occasional complaints from both nurserymen and from orchardmen relative to supposed injury to trees by hydrocyanic acid gas. Probably none of us, however, have recognized these complaints as general because they were not openly brought to our attention. When the matter was first brought to the writer's attention a year ago by Mr. R. A. Simpson, following his presentation of the subject to the Illinois Horticultural Society, we immediately made an effort to gather

evidence relative to the basis for the complaints and the possible remedies for the situation.

The letters received by Mr. Simpson from prominent nurserymen and orchardmen from eight or ten states, were unanimous in condemning the present methods used in treating nursery stock and in presenting evidence to prove the injurious effect of the gas on trees. In our personal talks with nurserymen and orchardmen in Indiana similar views were expressed. Nearly all admitted its effectiveness as a scale destroyer and that it was probably harmless to trees which were perfectly dry at the time of fumigation but that it was impractical to always have trees in the right condition for fumigation and that varying results are unavoidable.

We would quote a few extracts from letters received by Mr. Simpson which we know to have come from nurserymen and orchardmen who are reliable and who are themselves interested in preventing the spread of harmful insects.

One writer says, "If fumigation is done when the trees are perfectly dry, both tops and roots, with chemicals of proper strength, and in the hands of a careful and competent man it is all right, but there have been more trees damaged by fumigation than have ever been benefited, in the writer's judgment." Another nurseryman writes: "After we began fumigating our stock we received a lot of complaints that the trees were not breaking bud and that they were practically losing from 90 to 100 per cent of the stock we had delivered. We know from our own personal experience that under certain conditions nursery stock will probably not be injured from fumigation, but the conditions vary. One can hardly tell just when they are exactly right. We believe that if trees were thoroughly dried off, roots and top, before placing them into the fumigating room, and then watched very carefully, that there would probably not be any damage, but let there be the least moisture on the roots, or the twigs of the trees, and the fumigation is done according to the present formula, we are satisfied that injury will result. The great trouble with fumigation, as we see it, is that you are never certain just what you have done; whether you have killed the scale, if any, or whether you have not killed all the scale. There is no way to determine excepting to await results." Most of the men answering Mr. Simpson's inquiry reported specific cases of injury. The orchardmen were equally emphatic in their wish to plant only trees which had not been fumigated.

The following extract expresses the view of at least one state inspector: "This fall, one of the leading inspectors of a large fruit-growing

state called on us, and as he is handling trees himself and is also planting out some orchards of his own, he asked us if we would not send him trees without fumigating, although the laws of his state are very strict along this line. We told him that we would have to obey the state law, and he did not place his order with us, and has not up to this date. The fact of the matter is, this man told me personally that thousands of trees coming into his state, that had been fumigated, were injured and he did not want his fumigated." Can we wonder at the complaints when those whose duty it is to uphold the law attempt to evade it and who point out in such a striking manner the possible harmful results if properly enforced?

Where ideal conditions are obtainable, as is possible in experimental work, fumigation with hydrocyanic acid gas can be done with effective results and without injury to trees. However, even under such conditions, injury is possible. Mr. K. C. Sullivan in summarizing his investigations on the treatment of nursery stock[1] writes, "All strengths of the hydrocyanic acid gas caused more or less injury to the plants.* * * The 1–1–3 formula should always be used in fumigating nursery stock, and the stock should be dry. There may be greater danger of injury to plants, but the scale will be more completely controlled, and this is the most important factor." Do entomologists realize that while the control of the insect is a most important factor that it is equally important that the remedy be not more severe and fatal to the plant than the insect itself?

With their belief that fumigation may sometimes injure stock, many nurserymen, otherwise conscientious, probably do not take the pains to practice fumigation in a way to get effective scale control.

These points bearing on the fumigation of nursery stock have been briefly discussed to emphasize the need of further investigations to prove or disprove the use of hydrocyanic acid gas for nursery trees, to secure other means, if necessary, which will be thoroughly effective and harmless to trees, cheap and practical. The results should be sufficiently definite and clean cut that we will have reason to retain or change our state law. We believe there is no question that when thoroughly used under conditions which are practical in the nursery that the gas may be harmful to nursery trees and that complaints from nurserymen and orchardmen are justified.

Believing the subject one which could best be handled through the Crop Protection Institute, the suggestion has been made to the American

[1]Bul. Mo. Agr. Exp. Sta., No. 177, Dec. 1920, p. 34.

Nurserymen's Association to appropriate a sum to permit a complete and thoroughgoing investigation. It is not unlikely this Association will make such an investigation possible and in such an event, the entomologists are urged to carry on such tests in their respective states as may be necessary to corroborate the results.

IMPORTANT FOREIGN INSECT PESTS COLLECTED ON IMPORTED NURSERY STOCK IN 1923

By E. R. Sasscer

(Abstract)

During the year insects were intercepted on plants and plant products arriving from some ninety-three countries, islands, and provinces. Ninety-one coccids identified to the species were collected and many others were intercepted which could be placed in the genus only. During the months of January and February a number of shipments of French nursery stock arrived infested with such insects as the Sorrell Cutworm (*Acronycta rumicis* L.), the White Tree Pierid, (*Aporia crataegi* L.), *Notolophus antiqua* L., and *Calophasia lunula* Hufn. The condition of these plants was promptly brought to the attention of the Chief of the Phytopathological Service of France, which resulted in subsequent shipments showing a much less degree of infestation. The Oriental Fruit Moth (*Laspeyresia molesta* Busck) was found to infest peaches from China; and *Emphytus cinctus* L. was taken on a number of occasions on Manetti stock from France, Holland, Ireland, and England. Three shipments of pear seedlings from France bore nests of the Brown-Tail Moth (*Euproctis chrysorrhoea* L.); and the European earwig (*Forficula auricularia* L.) accompanied fuchsias from Germany and special permit material arriving from England and Ireland.

The European Corn Borer (*Pyrausta nubilalis* Hubn.) was taken in a number of shipments of broom corn arriving from Italy and Hungary; and the Pink Bollworm (*Pectinophora gossypiella* Saund.) was taken in cotton seed arriving from Hawaii, Mexico, Porto Rico, England, and Dominican Republic. Grapes from the Province of Almeria, Spain were found to be infested with the Mediterranean Fruit Fly (*Ceratitis capitata* Wied.); and this insect was also collected in apples from France, peppers, chrysophyllum, coffee berries, *Jabosa malaccensis*, avocados, and rose apples from Hawaii; and sapodillas, mangoes, and guavas from Jamaica were infested with the West Indian Fruit Fly (*Anastrepha fraterculus* Wied.). The Mexican Fruit Fly (*A. ludens* Loew)

was taken in mangoes and oranges from Mexico; and an unrecognized species of *Anastrepha* was present in mangoes and plantains from Porto Rico and oranges from Trinidad.

Egg masses of the Gypsy Moth (*Porthetria dispar* L.) were found attached to raw cork arriving from France; and the following wireworms were found in soil accompanying privet plants from Norway: *Athous niger* L. and *Agriotes sputator* L. Irish potatoes from Peru were infested with a species of *Trypopremnon;* and Mexican grown potatoes used as ships' stores were found to contain larvae of *Epicaerus cognatus* Sharp, which apparently does not occur in the United States. The latter insect has been found in potatoes arriving at New Orleans, Galveston, and Baltimore. A complete list of the insects and plant diseases intercepted on plants and plant products for the calendar year 1923 will be published elsewhere by the Federal Horticultural Board for the use of plant quarantine officials.

AMERICAN PLANT PRODUCTION UNDER QUARANTINE

By R. Kent Beattie

(Abstract)

With every importation of plants there is a risk of bringing plant pests. America needs plants. Quarantine 37 has developed a system by which propagating stock can be brought in under safeguards and the plants produced here. The quarantine has been in effect four and one-half years. Three thousand, one hundred and seventeen special permits have been issued: importation has been made under 2,205; 291 are still valid; 55,542,302 plants have been authorized entry; and 29, 885,712 imported. 18,796 varieties have been requested; and of these 93 1/10% have been authorized entry as unavailable for propagation in America.

American plant pathologists and entomologists have the opportunity of assisting this resulting great American horticultural development by studying the pathological and entomological problems faced by American plant growers.

REPORT OF COMMITTEES

Dr. T. J. Headlee, as Chairman of the committee appointed at the Boston meeting of the Section of Horticultural Inspection to look into the desirability of a uniform inspection certificate, submitted the following report:

STATEMENT OF THE PURPOSE, THE ORIGIN AND THE WORK OF *a Special Committee* FROM THE SECTION OF HORTICULTURAL INSPECTION OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS ON THE UNIFICATION OF NURSERY INSPECTION IN THE UNITED STATES

PURPOSE

During the Boston meeting, held in 1922–1923, before the section of the American Association of Economic Entomologists devoted to Horticultural Inspection, Mr. F. F. Rockwell read a paper on the subject of "Bugs, Bugologists, Bugaboos and Nurserymen" in which he entered a strong plea from the nurserymen's standpoint for uniform inspection and certification (particularly the latter) of nursery stock.

During the same meeting Dr. Leonard Haseman, State Entomologist of Missouri, presented a paper entitled "Inspecting Nursery Stock at Digging Time," Jour. Ec. Ent. Vol. 16, on pages 143–144 of which he brought out, from the official inspector's standpoint, the necessity of uniform inspection and certification of nursery stock.

The chairman of the section, Mr. E. N. Cory, was empowered by a motion to appoint a special committee, the business of which should be to see what could be done toward working out the unification, of which the nursery business, according to Mr. Rockwell, stood so greatly in need.

The committee on resolutions of the American Association of Economic Entomologists, in submitting its report after this action had been taken in the section of Horticultural Inspection, included the following statement, which was duly passed by the Association:—

> "*Resolved*, That it is the sense of this association that a uniform United States tag should be required to permit interstate movement of nursery stock and that the machinery necessary to the qualifying inspection should be worked out co-operatively between the United States Department of Agriculture and the authorities of the various states."

ORIGIN

Mr. E. N. Cory appointed the following committee:—Thomas J. Headlee, New Jersey, Chairman, F. M. O'Byrne, Florida, G. M. Bentley, Tennessee, E. C. Cotton, Ohio and E. R. Sasscer, Washington, D. C. After much correspondence it was found by Mr. Cory that Mr. E. C. Cotton could not serve and Leonard Haseman of Missouri was appointed in his stead.

WORK OF THE COMMITTEE

This committee was not able to hold any meeting until the Cincinnati assembly of the American Association for the Advancement of Science, although a considerable amount of correspondence was carried on among the members. At the meeting of the committee held in Cincinnati, it was decided to present a report to the Section of Horticultural Inspection of the American Association of Economic Entomologists in which was laid down a tentative plan for the creation of a strong organization adequately financed to carry on the necessary inspection work of the country and to carry out that work along the lines of certain general principles, which, it was decided, to include also in this tentative report. It was also decided to ask either the discharge of the present committee or its continuation with power of enlarging its personnel as it saw fit. The nature of the plan included in this report follows herewith:—

Main Outlines of Plan for Unification of Nursery Inspection of the United States

The enormous and confusing variety of rules and regulations now governing the movement of nursery stock (including greenhouse stock) from various parts of the United States into other parts of this country work, it is believed, an unnecessary hardship upon both the nursery business and the nursery inspection services of the various states and of the United States Department of Agriculture. Many nurserymen complain bitterly of the unwarranted interference which these rules and regulations create in the conduct of their business and horticultural inspectors frequently find themselves at a loss, not only to understand the usefulness, but the meaning of many of the rules and regulations now in existence in the various states.

In view of these facts the following proposal is submitted for the purpose of seeing whether this multiplicity cannot largely be done away with and, at the same time, the protection rendered to agriculture be made fundamentally better and more far-reaching.

ORGANIZATION TO DO THE WORK

The organization to perform the work of preventing the spread of injurious insects and plant diseases through the distribution of nursery stock of all kinds originating within the boundaries of the United States shall be: (1) Composed of the Federal Horticultural Board and the Inspection Services of the various States; (2) Controlled by a board of directors of six men trained and experienced in work of this sort. Three members of this board shall be designated by the Federal Horticultural Board and three members shall be elected by the Inspection Services of the various states. Each of these three members representing the Inspection Services of the various states shall be chosen from the standpoint of geographical location, one representing the northern, one representing the southern and one representing the western sections of the United States. The full term of office shall be three years and the terms of two members shall expire each year.

INSPECTION

Preliminary inspections shall be made at any time during the year when, in the judgment of the controlling board of the combined service, such action is likely to lead to the discovery of injurious insects or plant diseases that either could not be found at shipping time, or could be eliminated by the nurserymen previous to shipping time.

Inspection shall be made at the time the stock is offered for shipment and the condition of this stock with regard to injurious insects and plant diseases shall form the basis for issuance of certificates.

CERTIFICATION

Certificates issued for inter-state shipment shall be United States tags. Certificates shall cover only the stock to which they apply as shown by accompanying list. Certificates shall specify the territory into which the stock covered by them may be shipped. Certificates shall cover only the condition of the stock as far as injurious insects and plant diseases are concerned.

FUNDS

The moneys necessary to finance this joint organization shall be drawn from both the Federal Horticultural Board and the Inspection Services of the various states.

The total fiscal requirements for the inspection work in any state shall be determined and the funds to meet the needs shall be drawn equally from the Federal Horticultural Board and the Inspection Service of that state.

The Committee on Nominations for the year 1924 reported as follows: Chairman, E. R. Sasscer; Secretary, W. B. Wood. On motion, the ballot was cast and these officers elected for the ensuing year.

There being no further business, the session adjourned at 4:30 P. M.

BIOLOGICAL CONTROL OF PRICKLY-PEAR IN AUSTRALIA: CONTRIBUTING EFFORTS IN NORTH AMERICA

By John C. Hamlin, *Officer-in-Charge,*
Prickly-pear Investigations, Commonwealth Prickly-pear Board

Abstract

The introduction from North America of natural enemies of Australia's introduced prickly-pear pest has been under way about three years. This paper records the methods of rearing, packing, and shipping the insects, and the equipment employed in this special project. The insects shipped, number of times sent, and the number of individuals consigned are also briefly shown. The relation of the North American work to the present effort in Australia is summarized. Notes on several important cactus insects from Mexico are included, as is a statement of the cactus diseases dealt with.

Introduction

In furtherance of the Australian Government's project for biological control of the prickly-pear pest, North and South America were selected as the areas whence the natural enemies of cactus were to be imported. This statement deals with the work performed in North America in connection with studying, collecting, breeding free from parasites, and forwarding cactus enemies to Australia. During the two years ended October 31, 1922, the writer (then Entomologist and Biologist to the Board) was charged with this phase of the work, while Mr. E. Mortensen, Assistant Entomologist, continued the work during the succeeding sixteen months.

Acknowledgments

Both the Board and the writer are deeply indebted to many individuals and institutions throughout the United States and Mexico. Below are mentioned only those who were especially instrumental in bringing about the results recorded in this paper.

Throughout the work in North America, Doctor W. D. Hunter's close contact with it has enabled him to render the Commonwealth

Prickly-pear Board an invaluable service in the capacity of directing agent. The accomplishments have been profoundly influenced by his direction.

The helpfulness of Doctor L. O. Howard, both personally and through his staff of assistants, has been a notable contribution to our work. Entomological specialists of the United States National Museum have been unanimous with their generous aid at all times. Messrs. J. L. Webb, D. C. Parman, and T. C. Barber of the Bureau of Entomology have been constant sources of help.

To Doctor David Fairchild we are especially indebted for making available the Plant Introduction Garden at Miami, Florida as a field station, and for arranging several most useful connections with various people. His officer at Miami, Mr. Edward Simmonds, gave unstinted aid throughout the Florida work.

Doctor J. J. Thornber sent specimens of a cochineal insect from Arizona which is among the most important organisms dealt with in the work.

Doctor J. K. Small generously allowed the use of his cactus garden on the Charles Deering estate at Buena Vista, Florida, and the superintendent of this estate, Mr. Morrison, has been most helpful.

For extensive helpfulness in regard to the cactus diseases Doctor F. A. Wolf is an outstanding figure. Doctors W. A. Orton, O. F. Burger, and J. J. Taubenhaus were also contributors to our work in this connection.

During investigations in the Republic of Mexico, Doctor A. L. Herrera, Mr. J. M. Gallegos, and Doctor N. P. Escobar have most kindly facilitated our work.

One of the greatest contributions was that of the Oceanic Steamship Company. All consignments were sent via their S. S. "Sonoma" absolutely free of charge, and the company designated the Second Officer to give personal care enroute as per our instructions. Furthermore, this generous concern returned all empty shipping cases from Australia without cost. In this way a total of 207 cases were transported for the Board. Mr. H. I. Graham was largely instrumental in making these concessions.

Preliminary Activities

During November and December, 1920 the writer was fortunate to secure an excellent orientation with the project by conferring with many specialists in subjects pertaining to the problem, by inspecting the

Gypsy and Browntail Moth and European Corn-borer laboratories near Boston, and by a survey of the cactus country of Texas.

The field survey of southern Texas, outlined by Doctor W. D. Hunter, included Kingsville, Brownsville, Laredo, Uvalde, and San Antonio. Aside from permitting an acquaintance with the cactus enemies, this round made possible the selection of the most suitable locality for subsequent Texas work. The considerations affecting the choice were: number and abundance of cactus insects, presence of a United States entomological station with available working space to spare, accessibility of cactus to such laboratory, and availability of rapid transportation to the port of departure, San Francisco. Uvalde, fulfilling these conditions most satisfactorily, was chosen as the future seat of operations in securing the bulk of the Texas cactus-insect complex.

Most valuable were the series of conferences extending over several days, held with the late Mr. J. D. Mitchell at his home in Victoria, Texas. Many hints relating to the various cactus insects, drawn from Mr. Mitchell's previous extensive observations on this group, proved a great help later.

Organization

During the first half-year period, the writer was assisted by a boy for three months. Later, Mr. E. Mortensen was secured as Assistant Entomologist. During the last year and a quarter of the period under discussion the force consisted only of Mr. Mortensen and boy help. Through the kindness of Doctor Hunter the occasional help of Mr. T. C. Barber of the United States Bureau of Entomology was made available. In this way the variety of insects handled at Uvalde was increased by the sending of other species from Brownsville by Mr. Barber.

Equipment

The importation of insects at the laboratories visited in Massachusetts was limited to forms parasitic or predaceous on other insects, and the methods of packing and shipping could not be adapted to use in our problem of sending plant-feeding insects. Furthermore, the period in transit to Australia would occupy from four to five weeks, also entailing the passage through tropical conditions into the southern hemisphere where the organisms would be subjected to directly opposite seasons from those of their native habitat.

Obviously, then, these considerations marked the packing and shipping conditions as a prerequisite to the successful introduction of the cactus insects to Australia. Considerable attention was, therefore,

accorded the designing of shipping cases. The type found to be most suitable is shown in Fig. 1, Pl. 7. This case is a modification of the Wardian case used in shipping nursery stock. Its special features deserve mention here.

The outside dimensions in inches of this case are: length, 40; breadth, 18; height at sides, 15; height at middle, 24. It is put together throughout with screws. Both sides of the top are removable. These tops are fitted on the inner side with brass gauze of 50 meshes to the inch, and exteriorly with "rat wire" of 3 meshes to the inch. These two coverings are separated by the thickness of the frame of the top pieces—about $\frac{7}{8}$ of an inch. Exteriorly, above the rat wire are iron straps at intervals of about 4 inches which clear the protective rat wire by $\frac{1}{2}$ inch, adding further protection to the fine brass gauze. At each end is a beveled-edge door fitted with a cupboard lock, and a ventilator. These parts are covered interiorly and exteriorly with brass gauze. The bottom is provided with two or more small openings to act as drains. They are covered interiorly with brass gauze, and protected exteriorly by squares of galvanized sheeting. The handles project 6 inches beyond either end of the box.

A case of such construction cannot be placed on end by careless transportation employees because of the projecting handles. This type of handle also prevents close packing against the cases of other materials in the express or baggage car, thus insuring ventilation. The doors are serviceable in introducing the insects after the case has been packed and also in allowing the custodian on board the steamer to place water directly on the sphagnum moss in which the cuttings are rooted. The sloping top pieces provide excellent ventilation and allow ample sunlight.

Some of the earlier cases had $\frac{3}{16}$ inch plate glass in the tops instead of the brass gauze, but the latter material is far superior on account of the additional ventilation permitted. All of the later cases were made slightly larger.

This type of shipping cases has proved to be excellently adapted to the requirements of the plants and the insects as well as to the handling methods of transportation employees. They have been used also in shipping insects from point to point in the United States and Australia, and will undoubtedly be used in future sendings from Argentina and Mexico should the Board undertake work there.

The contemplated work successively in various sections of North America demanded the designing of a suitable type of rearing cage

which could readily be dismantled, crated and shipped to the next field headquarters. The standard type decided upon is shown in Figs. 3, 4, Pl. 7.

This cage is 30 inches long by 24 inches deep by 24 inches high. The frame is covered on the inside by a double thickness of that grade of cheese cloth known as sanitary cloth. The tacked edges of cloth are more firmly held down by placing a ½ inch by ½ inch strip over them. This strip is of the same thickness as the lumber in the frames, and is set just one-half inch from the edge of the frame. The cage when assembled is held together by three screws along each corner. The top, fitting snugly into place, rests upon the top half-inch strips of the sides and ends, and needs no fastening. It therefore acts as a door. By virtue of the half-inch strips a three-way fit is secured along each line where one piece of the cage attaches to another.

The cloth of the cage provides ample ventilation and a sufficiency of sunlight. When dismantled each unit part of the cage has its own covering of cloth intact. After crating and shipping, a minimum of time and labor is required to reestablish the cage. The frame is readily recovered with cloth by dismantling, removing the half-inch strips, and later replacing them.

The cage itself has no bottom. It rests upon the earth in a wooden tray which, in turn, is supported by a stool, the legs of which are immersed in cans of water. This expedient safeguards the contents of the cage from the depredations of ants. The cactus is planted in the earth which fills the tray. The frame-cloth cage is securely wired to the tray which holds the earth, effectually preventing overturning by high winds.

This rearing cage was used throughout the North American work and was found by the writer to be equally suitable in Australia. The demountable feature has effected a considerable economy in the North American work.

Small, ventilated wooden cases with screw-on tops were found most useful for posting cactus, bearing fungi and bacterial soft-rot to Australia. They have been of great service also in sending living insects from place to place in the United States and Australia.

Preparation of Material Before Shipment

Preliminary to all actual preparation of material was the collection of the various organisms in the field. This activity necessitated, of course, a simultaneous study of the identities, habits, preferred hosts,

habitats, and degree of injury of all species. The cactus insect bulletin[1] proved an invaluable guide along such lines. All of the principal cactus insects were found in the field, and two new species were discovered.

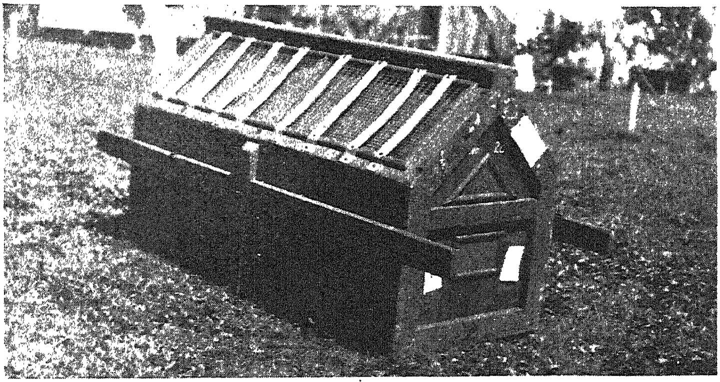
The work of rearing the field-collected insects free from natural enemies occasioned the devising of methods applicable to each species, and drew heavily upon the knowledge of their life-histories obtained by the observations cited above.

The cactus insects occurring naturally in the field in North America, are, in general, rather heavily handicapped by natural enemies. The procedure followed was to confine the collections of selected species with their host plant in the cloth cages above described. Each species was, of course, collected most readily in certain stages, and by certain methods, the details of which need not be mentioned. Upon appearance of adults, these mature individuals were transferred to another cage containing only clean cactus, and placed under suitable conditions to induce mating and oviposition. The deposition of eggs in perfectly tight cages insured a stock free from enemies. Eggs so laid were collected and placed in other cages where only clean cactus was available. These eggs were the beginning of a parasite-free stock which was shipped either as eggs or in a more favorable stage of development, depending upon the species in question.

It is apparent that the capacity-allotment of field-collected adults to a single cage should normally produce sufficient eggs with which to stock to similar capacity a number of such cages. Experience in rearing taught the number of individuals of a given species which constituted the capacity of the cage. There was derived, then, a rough ratio of expansion in terms of cages from generation to generation for each species. These principles, arrived at by field and laboratory experience, when applied to operations in Australia where the immediate need was expansion, greatly expedited the increasing of the introduced insects.

Since the cottony cochineal insects produce living young instead of laying eggs, and because of the nature of their natural enemies a different procedure was necesasry. Young cochineal crawlers where abundant have a tendency to mass themselves on the topmost spines of the plant on which their parents live. By holding a piece of cheese-cloth beneath such a crowded spine and thumping the spine, the crawlers may be transferred to the cloth without injury. This cloth is then placed in a cage containing cactus which has undergone a most minute examination

[1]The Principal Cactus Insects of the United States, by Hunter, Pratt and Mitchell (U. S. D. A. Bur. Ent. Bull. 113, 1912).



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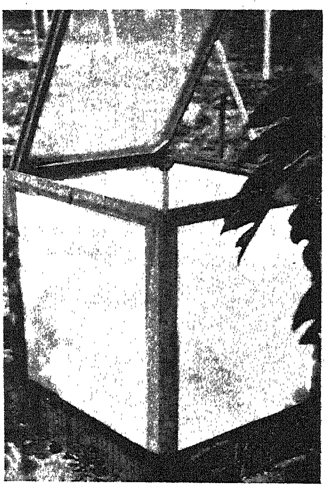

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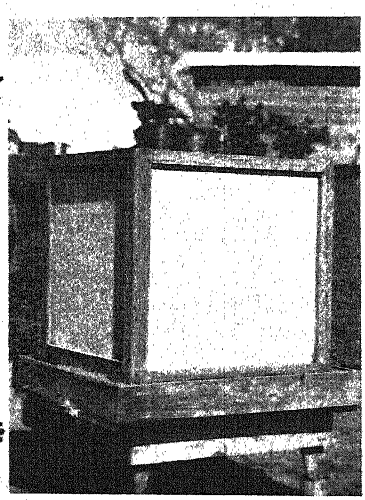
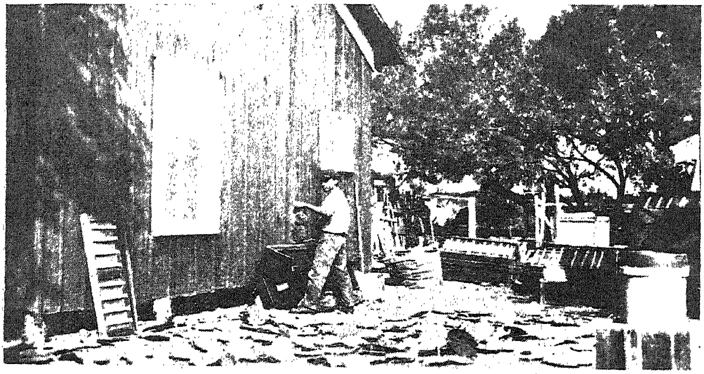


4.

Equipment and Materials Used in Introduction of Cactus Insects
1.—Case used in transoceanic shipment of cactus insects.
2.—Preparation of sphagnum for packing cactus in shipping case.
3.—Interior construction of demountable rearing cage.
4.—Cage assembled.



1.

2.

Stages in Packing of Cactus for Insects Enroute to Australia
(Lower photograph by courtesy of Mr. E. Mortensen).

to free it from all other insects. The crawlers then leave the cloth and settle upon the cactus, starting a culture free from enemies. The edges of doors to cochineal cages must be kept sealed with paper to prevent the entry of any of its many natural enemies.

The volume of insects constantly handled in the insectary was necessarily greatly beyond the requirements of the next consignment. In the first place, several cages of each species were necessary to insure a sufficiency of material in the event that certain cages should become contaminated with natural enemies. Again, since shipments could be forwarded on only one steamer departing at stated intervals, a number of cages of each species in several different stages of development were essential in order to have available the most favorable stage for shipment at the time the consignment was to be forwarded.

In several instances field-collected material was shipped to Australia. This was due, in part, to our inability to give sufficient detailed study to exceptional species while caring for the large stocks above mentioned. Again, such sendings were sometime made to meet the exigencies of the situation as regarded the needs in Australia and the possible termination of the North American work.

The North American force had neither the time nor equipment required to prepare pure cultures of the disease-producing organisms. Consequently, the writer found it necessary to send infected cactus segments or to rely upon the courtesy of several phytopathologists to supply pure cultures for us.

Shipment of Cactus Insects

The great bulk of insects was shipped in the large cases, while small numbers of certain species were sent in the small mailing cases. The latter were, of course, handled as parcel post, there being limited ventilation, no sunlight, and abnormal temperatures.

At the outset the shipping cases were placed partly on deck under outside conditions and partly in that chill-room most remote from the refrigerating machine. The unfavorable results secured from the chill-room portions of the first few shipments sufficed to eliminate that method of shipping.

The packing of various insect species was greatly influenced by their observed tendencies in the field and by the experience gained from rearing them in the insectary. These previous phases of work enabled decisions as to the method of packing the cactus, kind of cactus suitable, stage of insect best adapted to shipment, and number of indi-

viduals which would constitute the capacity of the case for each different species.

Cactus of a nature suited to each particular insect species was carefully selected so as to be free from all insects and diseases (except possibly *Hendersonia opuntiae* which is present on practically every plant in the southwestern cactus area). The presence of cactus anthracnose, for instance, would cause havoc among the cactus plants when passing through the tropics and the reduction of cactus would react against the insects being shipped. It is needless to go into detail regarding these specific points as related to each species, and I will let it suffice to mention one instance of a moth (*Mimorista flavidissimalis* Grote) with a very short life-cycle. This insect feeds only upon the very young, tender joints of cactus ("nopalitos") and reaches the adult stage about 28 days after egg deposition. The insects consigned from the United States to Australia must usually remain in the cases from five to six weeks. In other words, even if shipped as eggs the adults would emerge enroute and would require nopalitos on which to oviposit. Accordingly, cases to contain *Mimorista* were always packed with a sufficiency of nopalitos to insure the development of the eggs or larvae sent, and provision was also made for oviposition of the issuing moths. Old stumps of cactus which have been heavily pruned and have lain unrooted for several weeks, will begin to send out many young joints shortly after being supplied with heat and mositure. Such stumps were also included in cases to contain *Mimorista*, and they made available a fresh supply of nopalitos enroute for oviposition and development of the second brood of larvae.

The number of insects assigned to a given shipping case depended upon the amount of cactus in the case and the relative destructiveness of that particular insect species. It was highly important, then, that every possible piece of cactus be fitted into each case. The clean cactus selected from the field as suitable for a particular species, underwent further selection in the process of fitting together odd-shaped pieces to secure the maximum amount in the case. This selection and close packing of several cases made the preparation of a consignment a most tedious matter. The photographs in Plate 8 show different stages in the packing of cases for *Melitara junctolineella* Hulst and *M. prodenialis* Walker respectively.

To keep the cactus fresh and enable it to root itself enroute a material with high qualities of water retention was needed in which to surround the cut ends of the pieces of cactus. Soil could not be used because of the

danger of introducing to Australia many detrimental soil organisms. Sterilized sphagnum moss was found to fill all needs most excellently. Figure 2, Plate 7 shows sphagnum being prepared for moistening before packing.

By packing as outlined the cases weighed when full about 200 pounds, of which about 140 pounds was cactus.

The consignments of the first eighteen months were sent as excess baggage, and shipments were accompanied to San Francisco and seen properly placed aboard. This procedure, while essential at first, was very expensive. Subsequently the shipments were sent by express, unescorted.

Permission was kindly granted for the shipping cases to be placed on the forward end of the bridge deck of the steamer. Here they were sheltered behind an equipment house which protected them against spray and high waters. They were roped securely in place, and a canopy of canvas protected them from excessive sunlight. The removal of this covering for two hours during the morning and afternoon permitted the entry of sufficient sunlight.

Success in establishing North American insects in Australia was found to depend to a marked extent upon the time of year when the shipment was forwarded. Consignments sent in summer or winter are immediately subjected to reversed seasons upon arrival in the southern hemisphere, and this change renders establishment more difficult. It would appear, then, that shipment during the change of seasons would be most satisfactory since these changes are simultaneous in the northern and southern hemispheres. In other words, a given generation having passed through an American summer would, by shipment in the fall, continue through the summer conditions in the tropics and reach Australia at the beginning of the Australian summer, thus experiencing a continuance of unchanging seasons. This expedient of prolonging the American season does not hold for consignments dispatched in the spring because the winter conditions cannot be prolonged by virtue of the necessity of passing through the tropics. That this line of reasoning is correct is evidenced by the greater success attendant upon fall shipments than spring shipments. The most favorable period of shipment from the southern United States to lands across the equator extends from September to December. Shipment before September allows a touch of winter upon arrival in Australia, while shipment after December usually allows the same at this end.

Upon arrival at Sydney all consignments were met by a member of the Board's staff and escorted on the mail train to Brisbane.

Extent and Nature of Operations in North America

During the work in North America, Uvalde and Brownsville, Texas and Miami, Florida have served as field headquarters. Natural enemies sent by co-workers from Arizona, California, New York, and northern Florida have also been handled at one or more of the above temporary laboratories. Aside from these areas, other regions of the continent have been scouted for cactus enemies and deserve mention here.

During early spring a ten-day period was spent in inspecting cactus in the vicinity of Los Angeles, California. Nothing of special import was found.

During the summer of 1922 the writer spent a fortnight in inspecting southern Arizona and the State of Sonora, Mexico. Little prickly-pear was found, and *Moneilema*, *Narnia*, cochineal, and *Chelinidea* were the principal insects encountered. The *Chelinidea* bug proved new to science.

The urgent need of exact information regarding the cactus insects of Mexico led to more extensive field examinations during November, 1923. The writer and Mr. E. Mortensen visited the following points: Monterrey, San Luis Potosi, Mexico City, San Juan de Teotihuacan, Tepepam, Tlalpam, Guajamalpa, San Angel, and Cuernavaca. Mr. Mortensen later visited Tampico and Victoria in the State of Tamaulipas. The findings are worthy of brief discussion. The box of collected specimens posted to Brownsville, Texas was greatly delayed, and upon receipt larval specimens were in such poor condition that they soon died. They must therefore be referred to without scientific names.

At Tepepam, D. F., on November 13 the writer collected reddish lepidopterous larvae feeding gregariously in prickly-pear. A single larva of like kind was also taken by the writer at Cuernavaca, Mor.

On November 13 near Tlalpam, D. F., the writer found small lepidopterous larvae feeding gregariously within the terminal joints of a tomentose prickly-pear. The larvae were whitish with black spots above. From 25 to 50 individuals lived in close proximity within a small cavity. Excrement in pellet form was pushed through several small holes to the exterior where it collected in a light web and obscured the entrance holes.

Mr. E. Mortensen found at Guajamalpa, D. F., on November 19 white lepidopterous larvae living gregariously within a thick-jointed

prickly-pear. They did not inhabit the terminal joints and the pear exhibited little external evidence of their presence. Some 6 to 8 larvae inhabited the same cavity. The writer is of the opinion that this is probably a distinct species, related to the preceding one taken at Tlalpam.

Near Cuernavaca, Mr. E. Mortensen collected a single adult of *Cactophagus spinolae* on prickly-pear. Larval injury, presumably by larvae of this weevil, was also noted by Mr. Mortensen at Guajamalpa, D. F. on November 19. On the same date between San Angel and Coyoacan Mr. Mortensen and the writer discovered larvae, undoubtedly of this weevil, tunnelling in heavy middle joints of prickly-pear.

On November 10 the cactus collection in Chapultepec Park, Mexico City was inspected. The writer found a cochineal on *Opuntia tomentosa*.

At Tampico, Tams. Mr. Mortensen discovered lepidopterous larvae similar in appearance to *Mimorista flavidissimalis* Grote but differing from that species in habits.

On November 5 at Santa Catarina near Monterrey, N. L., the writer found bluish-gray larvae living internally in an Opuntia of the *Imbricatae* group.

On the same occasion Mr. Mortensen collected yellow weevil grubs in the distal ends of the same cactus.

In addition to the above insects, many of the species common to the Texas cactus country were seen. *Moneilema* beetles, apparently of many species not occurring in the United States, were found in relative abundance in practically all regions visited.

The first four insects mentioned above would undoubtedly prove of great assistance in bringing about biological control of prickly-pear in Australia. It is noteworthy that all of these occur within easy working distance of Mexico City, where transportation facilities are best. Inspection of the region during summer would probably bring to light other species which were not found during this winter survey.

Cactus-Enemy Complexes

Each cactus region of North America has a combination of natural enemies which tend to hold prickly-pear in subjugation. Most important among these natural enemies are the cactus insects, fungi, and bacteria. These natural complexes vary greatly in different regions of North America.

The subjugation of cactus in North America is not due to the action

of any one insect, one particular fungus, etc., but results from the combined effects of the natural enemies of the plant. In planning the biological control of prickly-pear in Australia we should, then, contemplate the establishment there of as large a percentage as possible of the complexes as they exist in America.

The cactus-enemy complex of Florida is quite different from that of Texas. In the latter region insects are more important than fungous diseases of cactus, while in Florida the fungi are much more numerous. Furthermore, there are wide variations in the cactus insects of the Uvalde and Brownsville regions in Texas. These three regions have been the principal contributors to the complex established in Australia. A cochineal from Arizona has also been included.

The various complexes of the United States are necessary in order to provide combinations of cactus enemies for the different climatic regions in Australia. To superimpose upon the United States complex the complexes of Mexico and South America would greatly enhance the chances of expeditious control of prickly-pear.

Consignments and Numbers of Insects Sent

During the period under discussion eleven consignments, totaling 111 cases were forwarded from the United States. Some species were not included in all consignments because they were not always ready for shipment when the S. S. Sonoma departed. The data pertaining to the various species are shown in the following table:

Table Showing Origin, Times Sent, and Number of Individual Insects Shipped

Melitara prodenialis	Fla.	7	5615
Melitara junctolineella	Tex.	8	2077
Mimorista flavidissimalis	Tex.	8	660
Moneilema sp.	Tex.	6	705
Chelinidea vittiger subsp. *aequoris*	Tex.	8	1897
Chelinidea vittiger subsp. *aequoris* var. *artuatra*	Fla.	6	1713
Chelinidea tabulata	Tex.	7	1151
Chelinidea canyona	Tex.	7	1326
Narnia pallidicornis	Tex.	5	1302
Asphondylia opuntiae	Tex.	6	14950[2]
Noctuelia elautalis	Tex.	4	350
Dactylopius tomentosus	Tex.	7	Several infested joints
Dactylopius confusus	Fla.	5	"
Dactylopius tomentosus	Ariz.	3	"
Dactylopius tomentosus	Calif.	1	"

[2]Estimated on basis of 10 maggots to each infested tuna.

Gerstaeckeria spp.	Tex.	4	2077
Scavenging flies	Tex. & Fla.	10	Very large number

A few insects sent have not been included in the above table. One of these was referred to in reports as *Melitara (dentata?)*, but was later identified by Doctor H. G. Dyar of the United States National Museum as *Melitara prodenialis* Walker. I have not included this insect in the table because it was sent only once and later died out. *Disonycha varicornis* Horn was also sent in small numbers but it was not reared because it feeds on a different type of cactus from any of the Australian ones.

Pathogenic Organisms Sent

The pathogenic organisms sent from Florida include the following: (1) a bacterial soft-rot, (2) common anthracnose (*Gloeosporium lunatum*), (3) zone spot anthracnose (*Gloeosporium cactorum*), (4) *Colletotrichum* sp., (5) *Phyllosticta concava*, (6) "pseudo-Hendersonia," (7) *Phoma* sp., and (8) *Perisporium wrightii*.

Those sent from Texas are: (1) *Gloeosporium lunatum*, (2) *Hendersonia opuntiae*, (3) "white scab," and (4) *Perisporium wrightii*.

Adequate provision for the efficient carrying out of the pathological phase of the prickly-pear project has not been possible in connection with the entomological work. This field is, however, full of promise and deserves the attention of an expert phytopathologist.

Accomplishments

The insects selected for introduction from the United States include 16 species which feed upon healthy pear, and 7 scavenging species which assist the plant feeders by extending the initial injury. All of these insects have reached Australia alive.

None of the scavenging flies have been established due to inability of both Australian and American laboratories to rear them in captivity. Several Australian flies promise to fill the place of the American scavenging flies in the cactus-insect complex. At any rate, an attempt to establish the American scavenging flies should be made subsequent to the establishment in the Australian field of the primary cactus insects.

Of the 16 primary cactus feeders, the midge (*Asphondylia*) and the fruit-worm(*Noctuelia*) have failed to breed in captivity. The four *Gerstaeckeria* weevils have been eliminated on account of their unimportant injury. The available effectives were further reduced by the failure of one cochineal (*Dactylopius confusus* Ckll.) to feed upon the

common Australian pest pears. Of the nine remaining species available, six species have increased in a satisfactory manner.

It is obvious, in view of the above facts and figures, that almost the entire present Australian effort relating to biological control of the prickly-pear pest is based upon the field and laboratory work in the United States. Considering the territory covered and the results achieved in forty months at an annual cost of three-tenths of the yearly appropriation, the whole operation in North America assumes an aspect of strict economy.

The North American work is planned to cease in May or June, 1924. Provision should immediately be made to enable the Board to secure from Mexico and South America other valuable cactus destroyers. By such action several other natural enemies of pear would be rendered available to strengthen the reduced complex already introduced from North America.

THE EFFECT OF DEFICIENCY AND EXCESS IN RAINFALL UPON THE HICKORY BARK BEETLE

(*Eccoptogaster quadrispinosus* Say)

By M. W. Blackman, *New York State College of Forestry, Syracuse, N. Y.*

Abstract

An epidemic of the Hickory Bark-Beetle started in Syracuse in 1912 and has extended to the present time, with a decided checking in 1915. This was preceded by semi-drought conditions over a period of several years before the epidemic started. While the trees were undoubtedly affected, as is shown by a study of the rings of growth, the indirect effect through the lessening of the vitality of the trees is not sufficient to account for all the phenomena. The greatest effect was the more direct one upon the insects themselves, as the deficiency came during the summer months. A deficiency at this time is beneficial to both adults and larvae, and an excess, as in 1915, acts as a distinct check. When the adults are active, continued rain kills many while feeding and establishing their burrows and also checks egg-laying. Excess rainfall, humidity and cloudiness kills the larvae because it produces an excess of water in the plant tissues and this is set free into the larval mines. Deficiency in rainfall has a beneficial effect upon both adults and larvae. This may be put to practical use. If it is known that there has been a deficiency in rainfall extending over several years, an intelligent lookout can be made for the first signs of undue increase of dangerous forms and these can be controlled before they reach epidemic proportions.

For many years there has been a general feeling among forest entomologists that there is a more or less direct relation between drought conditions and the incidence of epidemics of insects—especially of boring insects. As a usual thing this feeling has been suggested or hinted at as

a tentative hypothesis supported if at all by only general observations. One attempt to correlate such an insect epidemic with a deficiency in rainfall was made by Felt (1914).[1] He shows that an outbreak of the hickory bark-beetle began in the vicinity of New York City in 1908 and continued during the following four years. By a study of the Weather Bureau records for that locality he shows that: "From 1906 to 1912 inclusive, there has been a deficient rainfall, except for 1907 at which time there was an excess of only half an inch. The total deficiency during this period amounted to 28.56 inches." More significant still Felt shows that the deficiency in rainfall occurred mostly from June to September "During the growing months and at times most likely to affect vegetation adversely." In conclusion he states: "With the above facts in mind it seems reasonable to believe that these unfavorable climatic conditions may have reacted upon the trees, reducing their normal resistance considerably and resulting in conditions which were extremely favorable to the multiplication of bark borers."

The observations and deductions of Dr. Felt were very interesting to the writer for at the time they appeared he had under observation at Syracuse a similar epidemic infestation of the same bark-beetle. These observations have been continued during the last eleven years, 1913–1923, and the data collected furnishes the basis for some rather interesting hypothetical deductions. These deductions are based not only on a general study of the development and history of the infestation and a correlation of this history with meteorological data, but also takes into consideration the habits of the beetles during their larval and adult life, correlating this with weather conditions. The present writer also attempts to consider the physiological condition of the tree under different degrees of rainfall and the effect of these different conditions upon the attack of bark-borers. The deductions drawn are not presented as proven facts, but are offered as a working hypothesis which may serve to stimulate future intensive investigations upon the interrelations between climatic conditions and the development and control of bark-beetle infestations.

The infestation of the hickory bark-beetle at Syracuse was first observed by the writer in September 1913. It occurred in a pasture woodlot of nearly four acres. The sparse stand, clay soil, steep slope, close pasturing and absence of underbrush made the conditions of growth quite unfavorable for hickory. In all there were about 165

[1]Felt, E. P., 1914. Notes on Forest Insects. Journ. Econ. Ent. Vol. 7, pp. 373–375.

hickories in the grove. About a dozen trees had been attacked and killed during the summer (1913) and a number more were infested and partly killed. Several trees were also found which had been killed the preceding year. All of these killed trees were in one corner of the hickory grove and none of the trees showed the effect of the brood except in this one corner. No trees killed by the hickory bark beetle were found near Syracuse except in this one spot, although beetles were found in various places in felled trees and in broken branches.

During the following year (1914) 111 hickories in the grove of less than four acres were killed—76 per cent of those still alive the preceding fall. That summer there was little tendency in the way of dispersal of the epidemic shown. It is true that perhaps a half dozen outlying pasture trees were attacked and killed but none of these were more than a hundred yards from the main group. This of course is easily explained by the abundance of the proper host close at hand.

In the summer of 1915 thirty of the thirty-five remaining hickories in the woodlot were killed by the beetles and in addition to these four trees some half mile away were also killed. These thirty-four hickories were the only ones found within a radius of one and a half miles to succumb this year. Had the injuries increased in the same proportion as in the preceding year, close to a thousand trees would have been killed in the summer of 1915. There can be no doubt that this year there was a very decided decrease in the injuries resulting in a partial control of the epidemic. The explanation of this will be attempted later in this article.

The later history of the epidemic will be given in general terms only because as the beetle spread farther and farther from the original focus of infestation it became increasingly difficult to keep specific data. In 1916 the trees killed by the beetles in the area under observation were about as numerous as those of the preceding year but were distributed over a much wider area. Several trees in a wood lot a half mile south were attacked and killed and the tops of others were deadened. In an easterly and northerly direction the effects of the beetles were seen for about a mile and a half—the killed trees being mostly isolated hickories in pastures. In the several years following there was a progressive increase in the injury and a rapid spread, especially toward the north and east in the direction of the drive of the prevailing summer winds. By 1922 a great per cent of the hickories, especially pasture and roadside trees, had died at least as far east as Canastota (about 20 miles). Appearances all point toward a progressive spread from the original focus at Syracuse. On account of the absence of specific data, however, it is not

possible to be sure that beetles from several such foci of infection may not have combined.

The main facts of the history of this infestation to be emphasized and to be remembered in connection with the attempted explanation following are as follows:—(1) The consistantly rapid increase of the number of the hickory bark-beetle (as shown by the number of trees killed) from 1912—1914 inclusive; (2) the sharp reduction in the numbers of the beetles in 1915; (3) the lack of any marked increase or decrease in 1916; (4) the steady but gradual increase and diffusion of the insects from 1917 to the present time.

In the table given herewith the precipitation departures at Syracuse for each month of the years 1908 to 1922 inclusive is shown. By consulting this table it will be readily seen that there was an annual deficiency in rainfall for every year from 1908—1913 inclusive, a slight excess in 1914 and an excess of 10.24 inches in 1915. The total deficiency from 1908 to 1914 inclusive was 23.58 inches. A closer scrutiny of the data will show that much of this deficiency came during the three growing months of the tree—June, July and August.

An examination of the growth rings of thirty trees killed during the five years from 1912 to 1916 was made. A great diversity of conditions were found but these may be briefly recorded as follows. Of two trees killed in 1912 (the year of the incidence of the infestation in the wood lot studied) one showed very slow growth for a period of more than 20 years before its being killed, while the other, closely adjacent to it, showed normal growth up till 1908 with but a slight reduction from 1908—1912. Of five trees killed in 1913 two showed moderate reduction in the rings from 1908 to the time of their death, two showed similar reduction in growth from 1909, and one showed slight reduction from 1906—1908, an increase in 1909 and slight reduction from then till its death. Trees killed during 1914 and 1915 showed the same variable conditions. In some the reduction in the rings was never excessive while in others it was very great. In some the reduction in growth extended back many years, while in others it did not begin until 1910 or 1911. It is certain from this data that the deficiency in moisture extending over a period of several years has a decided effect upon the amount of new wood laid down by the tree. This effect is shown in some trees by an immediate and sharp reduction in the width of the growth rings, in others by a gradual reduction increasingly marked each year, while in other trees no effect is apparent until the deficiency has continued for several years. When the facts are all considered there can

PRECIPITATION DEPARTURES AT SYRACUSE

(U. S. Weather Bureau)

1908–1922

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
1908	+0.08	+0.43	+0.17	+1.02	+0.10	—1.11	0.00	—2.67	—2.00	—0.48	—1.73	—1.20	—7.38
1909	+0.86	+2.75	—0.92	+0.78	—0.55	—1.64	———	———	—1.14	—1.90	—1.41	—0.89	—4.06
1910	+0.33	+1.84	—1.75	—0.92	+1.37	—1.65	—0.72	—0.06	+0.48	—1.68	—0.52	—0.41	—3.69
1911	—0.03	+0.86	+0.33	—0.28	—1.18	—0.67	—0.62	—0.88	—0.06	—1.05	—1.21	+0.98	—3.81
1912	—0.61	+0.25	+0.96	+1.35	—0.17	—3.34	—0.52	—0.36	+2.77	—1.54	+0.25	—0.75	—1.71
1913	+1.66	———	+2.46	—0.30	—0.60	—1.79	—2.73	—1.17	—0.95	—0.08	—0.67	—0.25	—4.42
1914	+0.41	+0.62	+1.96	+1.96	—0.34	+0.51	—1.04	+1.90	—1.35	—2.00	—1.65	+0.51	+1.49
1915	+2.55	+1.05	—1.27	—1.52	—1.37	—0.42	+3.69	+2.12	+2.29	+1.19	—0.49	+2.42	+10.24
1916	—0.14	+2.13	+0.98	—0.34	+0.48	+1.23	—2.72	+0.09	+1.30	—1.77	—0.70	+0.21	+0.75
1917	+0.31	+0.93	+0.04	—0.04	+0.26	+0.57	—1.88	—0.45	—1.32	+1.46	—1.79	+1.38	—0.53
1918	+1.46	+0.22	—0.52	+0.38	+0.00	+0.33	—1.46	—1.88	+1.52	+0.35	—1.52	—0.39	—1.51
1919	—0.05	—0.21	+1.92	+1.49	+1.52	—2.30	+1.76	—1.33	—1.22	+0.48	—0.70	—0.41	+0.95
1920	+1.52	+0.02	+0.34	+0.88	—3.20	—2.35	+0.14	—0.75	+3.80	—2.53	—1.54	+0.73	+0.14
1921	—1.12	+0.67	+0.54	+0.59	—1.12	—0.06	+0.76	—0.94	—1.27	—0.11	+3.88	—1.70	+0.12
1922	+1.40	+1.03	+2.30	+0.16	+0.45	+12.03	—1.29	+1.54	—1.51	—0.96	—1.47	+0.19	+13.87

be little doubt that the continued deficiency results in a considerable but variable reduction in the vitality of the tree and increases (either much or little depending upon the individual tree) its susceptability to destruction by the bark-beetles. On May 7, 1924, increments were taken of ten living hickory trees growing under more healthy conditions in a woodlot about 2 miles south of the original center of infestation. Here there was no evidence of present or past activity of the hickory bark-beetle. The increments showed considerable individual variation but the average condition as compiled from the ten trees is as follows:—a gradual decrease in the increment from 2.2 mm. in 1907 to 1.5 mm. in 1914; an increase to 1.7 mm. in 1915; and again a decrease to 1.1 mm. in 1923.

In the view of the writer, after considering all of the data given and other data appearing later, the weakened condition of the tree is not sufficient fully to account for the rapid increase in the number of the insects and the resulting increase in the trees killed. It would seem, however, that an abnormality in precipitation during the months of June, July and August would have a decided direct effect upon the insects themselves—either favorably or adversely. It is believed that this direct effect would be of more importance in fostering an epidemic and certainly of greater importance in checking one than would be the indirect effect upon insects as exerted through its influence on the health of the tree. That any deficiency or any excess in rainfall during the three months period or any excess of cloudiness during the latter part of it would have an effect upon the beetles or their younger stages can be understood better when we consider the habits and seasonal history of the bark-beetle.

The hickory bark-beetle passes the winter as a fully grown larva in the outer portion of the inner bark of its host tree. The adult beetles emerge at Syracuse during the latter part of June, throughout the month of July and during early August. The height of emergence usually occurs during the first two weeks in July, but varies somewhat according to the advancement of the season. The adults fly at once to living hickory trees and feed for some time by boring into the young twigs and into the bases of the leaf-petioles. After feeding for some time—exactly how long is not known—the beetles fly to the trunk and branches where they may often be seen in hundreds creeping over the bark and examining every crack and crevice. Each female selects some place where the bark is thin, as in one of the longitudinal cracks, or under one of the loosened scales, and begins to construct her burrow. The entrance tunnel extends through the bark at a slightly upward angle and

when the surface of the sapwood is reached is continued longitudinally upward as the egg-gallery. After being fertilized the female beetle continues extending the egg-gallery. At each side she gouges out small niches, in each of which a single egg is deposited. In this process the beetle extends the gallery with her mouth parts. When it has been carried slightly beyond the last egg-niche she constructs another niche. Then in order to deposit the egg it is necessary that she back out of the burrow to the surface of the bark, reverse herself and re-enter the burrow

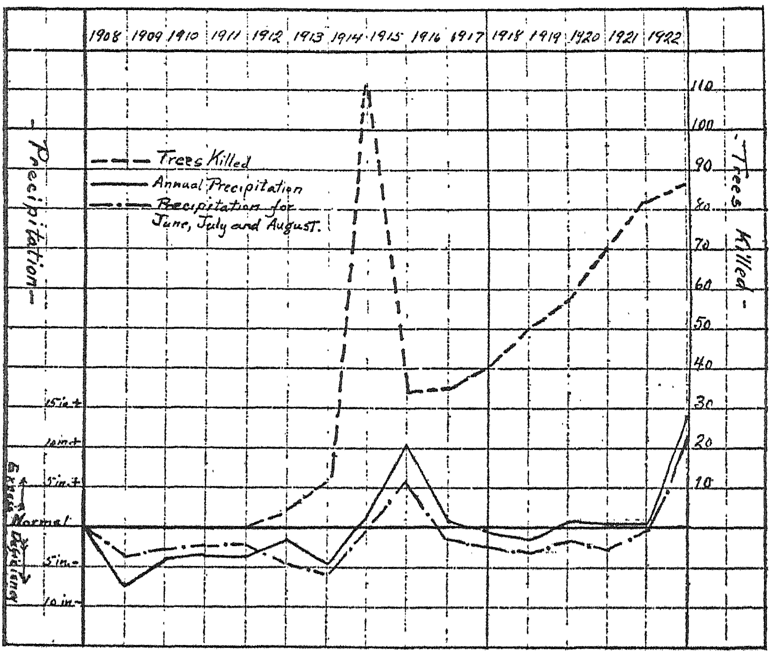


FIG. 11.—Graphs showing excess and deficiency in precipitation at Syracuse from 1908–1922 and relation to injury by the hickory bark-beetle. The rather close parallelling of the graph showing annual precipitation and that showing the conditions for the three growing months (June, July and August) is interesting in demonstrating that most of the departure from normal came during these three months. Also note that the incidence of the epidemic came on the year when the deficiency in precipitation for the growing months became greater than for the entire year. Note also that from this point on the graph representing the departures during the Summer months remains well below that representing the departures for the year—i. e. the deficiency is always greater and the excess always smaller, there being an excess only in 1915 and 1922. The effect of the excess in 1922 was slight as it was due to two very heavy rains occurring rather early in June. The graph showing "Trees Killed" is based on actual counts from 1912–1918. After that the number killed is estimated, due to the wide spreading of the epidemic from its place of incidence.

backward. When the egg is placed in the niche she creeps out of the burrow, turns around and enters it head first, packs the egg with frass and resumes her burrowing.

Such being the habits of the adult beetles it is, I think, very evident that a deficiency in rainfall during the time when they are on the wing, feeding on the leaf petioles, starting their brood galleries and laying the eggs, would be very much to their advantage. Conversely, an excess in precipitation at these times would result in the destruction of many of them. A deficiency in rainfall during late June and throughout July would work very much to the advantage of the beetles and an excess during this time would have the reverse effect. Departures from the normal during July—especially during the first half of the month, would be of greatest importance in their direct effect upon the adults. By consulting the accompanying table it will be seen that from 1908 to 1913 inclusive there was each year a deficiency in precipitation during the month of June. In July—the most important month in its effect upon the adult beetles—the deficiency in rainfall extended from 1908 to 1914 inclusive.

But it is the opinion of the writer that rainfall not only exerts this direct influence upon the adult beetles, but also, through the effect of excess or deficiency upon the physiological processes of the tree, exerts a perhaps greater effect upon both adults and larvae. A deficiency in rainfall would mean a lessened amount of moisture in the soil available for absorption by the root hairs. Such a deficiency also would be accompanied as a rule by a greater amount of sunshine and a decreased amount of humidity in the atmosphere. Thus at such times there would not only be a lessened amount of moisture available to the tree, but there would be an increased loss of moisture due to more rapid evaporation from the leaf surface. This would result in a lessening of the moisture content of the tissues of the tree and a decrease in the sap-pressure. It has been established by recent investigations of McDougal by means of the dendrograph, that during periods of sunshine when the loss of evaporation through the leaf surface is greatest, there is an actual measurable decrease in the diameter of a living tree, and conversely during periods of cloudiness an actual increase in the diameter. This can only mean that the effect of the cloudy weather is an excess in the moisture content of the tree, resulting in a swelling or turgidity of its component living tissues. Thus an insect, such as either the adult or larva of the hickory bark-beetle, boring through the living tissues of a tree would in wet cloudy weather release into its burrow a much greater

amount of water than it would under like conditions in a dry period of much sunshine.

Perhaps the most conclusive evidence of the influence of these several factors upon the bark beetles is furnished by the decided checking of their injuries due to the excess in rainfall during July and August in 1915. Corroborative evidence of the opposite effect of a deficiency in precipitation is, however, furnished by the development of the epidemic from 1912–1914 inclusive and by the renewed increase in damages in the years following 1915 when a deficiency again became evident. As will be seen by referring to the table, the first six months of 1915 showed a slight deficiency in precipitation so that the trees were in no better condition as to stored-up resistance than in previous years. In the second half of the year, however, there was an excess of 11.22 inches and of this excess more than half came in the months of July and August when the effect upon the beetles and their larvae would be greatest. As has already been stated, only 34 trees were killed, although the previous year 111 had suffered mortal injury. As we have already seen the reason for this could not have been due to the condition of the trees at the time the beetles emerged from their old hosts and there can be no reasonable doubt that the partial control if due to weather conditions was due to such as existed after their emergence.

The rainfall in July was 3.69 inches above the normal for the month. There was rainfall on 19 days and 21 days were cloudy or partly cloudy. In the first half of the month 10 days showed rainfall varying from .01 to 2.63 inches. This is the period when the adults are emerging and feeding upon the twigs and petioles—when they are most exposed to injury. In August the excess precipitation was 2.12 inches. Rain fell on 19 days, there being 11 rains during the first 15 days. There were but 3 clear days and of the remaining 28 days (cloudy or partly cloudy), 13 are listed as cloudy. This is the period when excess of precipitation, especially when accompanied by a greater amount of cloudiness than normal, would if our deductions are correct, cause a greater sap-pressure in the tree and in this way check the work of both adults and larvae boring in the living tissues.

At the time, the writer did not fully realize the significance of what was occurring and the observations made were not as detailed and systematic as would be desired. However, in September a number of trees—including not only those killed but also a large number not mortally injured—were examined. The most striking fact with regard to the killed trees was that the brood galleries were much shorter than

normally and as there is a fairly definite relation between the length of the gallery and the number of eggs deposited, a smaller number of progeny came from each pair than is normal. In addition to the trees killed this year many others were attacked but were not killed. In these, many burrows were started only to be abandoned before a single egg was laid. In other burrows a few eggs had been laid but did not hatch. In still others the egg-gallery had been continued for a distance of one or two centimeters upon the sapwood, eggs had been laid in niches on each side and the young larvae hatching from them had started their mines at right angles to the egg-gallery. However, in most of the burrows, either all or a greater number of the larvae had soon succumbed. Thus while many trees were attacked by the beetles in numbers sufficient, under normal conditions to have insured their death, only four trees outside of the immediate center of infestation were killed. The flight of the beetles in a northerly direction could be readily traced for more than a mile by the presence of aborted brood burrows in the trees attacked.

The writer explains these various facts as follows. The frequent rains during the first half of July destroyed a number of the adults while these were feeding upon the twigs and petioles. However, a considerable number of these survived in spite of the adverse conditions at this time and the continued excess in rainfall during the following month. Many of these beetles attacked the trees in swarms, and started their burrows. Where the beetles were present in excessively large numbers, their attack was successful and the trees were killed. Those emerging later, however, found practically all of the trees in the vicinity already fully stocked and were forced to migrate. Dozens of pasture hickories were attacked during late July and August but this was successful on only four trees. We have already seen that there was an excess in rainfall during August and—which is of at least equal importance—this month was excessively cloudy, there being only three clear days. The result of this was an excess of sap held in the living tissue of the tree—an increase in sap-pressure. Thus the adult in making the brood burrow was subjected to an excessive flow of moisture into her burrow and this moisture on account of the cloudy and humid conditions did not evaporate from the burrow entrance as rapidly as normally. Also during the frequent rainstorms the female was twice subjected to the danger of being washed away for every egg deposited. Doubtless also many females were never fertilized on account of the high mortality of the males, which remain outside of the burrows most of the time. Thus the

results were as follows. In many cases the burrow was started but was abandoned before eggs were laid. In other cases the egg-galleries were continued for some distance, although always short and a few eggs were laid. The larvae hatching from the eggs were for the most part soon overcome by the excessive amount of moisture set free into their burrows as these were excavated by the larvae. The mortality of the adults and larvae in the later burrows was much heavier than in those started during July because of the greater saturation of the soil, the greater amount of cloudiness and the consequently greater excess of water in the plant tissues.

If the truth of the hypothesis advanced should be established by future detailed and systematic observations, of what practical use would it be to forestry? To the writer it seems that it promises to be of great practical value. While it is manifestly impossible for man to so change climatic conditions as to control an infestation once thoroughly established, a thorough knowledge of the causes underlying the development of a bark-beetle epidemic and a full appreciation of the factors favoring the incidence of such outbreaks, will give to those responsible for the protection of the forests the ability to foresee a possible epidemic before this has really started. Thus, if it is known that a period of deficiency in rainfall at certain seasons weakens the resistance of trees to attack and at the same time favors the development of certain tree destroyers, an intelligent lookout may be made for the first signs of an undue increase in the known destructive agencies and these can be controlled by means of already known methods long before the infestation reaches epidemic proportions.

Even when, as is often the case, the meterological data for a given locality is lacking, there would seem to be an excellent chance of detecting adverse conditions due to a deficiency in rainfall or to other influencing factors, by a systematic study of increment borings. If a majority of these show a marked lessening of increment growth over a period of several years, an especial attempt may be made to detect a developing infestation before it becomes epidemic. Such an incipient outbreak can then be controlled before it becomes serious and thus prevent great possible damage. In other words, if taken in time prophylactic measures may be used rather than remedial measures.

THE SOLUBILITY OF ARSENATE OF LEAD IN THE DIGESTIVE FLUIDS OF THE HONEY BEE[1]

(*Apis mellifica*)

By HARRISON M. TIETZ

ABSTRACT

The purpose of this study was to find out how the solubility of arsenate of lead is increased by the action of the digestive fluids present in the alimentary tract of an insect. In making these determinations, the honey bee, *Apis mellifica* Linn., was taken as the insect and the solubility of arsenate of lead powder in water was taken as the unit of solubility. The conclusions drawn from this experiment are as follows, (1) The solubility of arsenate of lead does not seem to increase when the powder is acted upon by the fluids in the oesophagus. (2) The digestive secretions of the honey stomach and stomach render the poison at least one and one quarter times as soluble. (3) The action of the intestinal juices is to throw at least three and three quarters times as much of the powder in solution as would be dissolved by water alone.

In order that a poison may be absorbed by the body and so cause death, it is necessary that it should be in a soluble form. When arsenate of lead is taken into the alimentary tract of an insect, it is very insoluble. When we realize that the average arsenate of lead powder contains but 32% arsenic pentoxide, and that the insect consumes but a small quantity of the spray mixture, we can readily believe that the solubility must increase when the powder comes in contact with the digestive fluids in the alimentary tract, otherwise the quantity of arsenic capable of assimilation would be so small that the insect would be unharmed by its presence in the blood. It is the aim of this paper to show that arsenate of lead becomes more soluble when acted upon by the digestive fluids.

Before entering upon a discussion of methods and results, the writer wishes to state that his findings are merely indications of what may take place in the insect's body. In the alimentary tract of the living animal, the percentage of solubility may be even greater than the percentages obtained from the writer's experiments. This is true for two reasons. In order to get a sufficient quantity of liquid with which to work, it was necessary to dilute the gastric fluids. The more concentrated digestive fluid, to be found in the living animal, may have the power to throw more of the arsenate of lead in solution. Another factor to be considered is that the alimentary tract while it remains in the living insect may continue to secrete gastric fluids and so produce larger quantities of the solvent resulting in more arsenate of lead being dissolved. When, how-

[1]Contribution from the Entomological Laboratory of the Mass. Agricultural College, Amherst, Mass.

ever, the digestive tract is dissected from the insect, the cells die and so do not produce as much of the solvent.

Determination of the Hydrogen ion Concentration

Since the reactions (acidity or alkalinity) of the various portions of the alimentary tract play an important part in determining how much arsenate of lead will be dissolved, the writer first determined the hydrogen ion concentrations of the various portions of the digestive tract. These portions were as follows—(1) the oesophagus, (2) the honey stomach plus the stomach, and (3) the remainder of the alimentary tract. The divisions were made in this manner because these portions are more or less shut off from their neighboring sections, while there is free communication for the gastric juices within the portions themselves.

The determinations were made as follows. Twenty-four bees were killed with chloroform and immediately dissected. The oesophagi of these bees were removed and placed in 12 c.c. of neutral water (Ph + 7). The honey stomach and stomach were treated in a similar manner and placed in a second flask containing 12 c.c. of the neutral water. The remainders of the alimentary tracts were placed in a third flask also containing 12 c.c. of the neutral water. At the end of an hour a sample was taken from each flask and tested with Phenol Red, Methyl Red and electrically. The solutions remaining in the flasks were kept 24 hours at about 15 C° and tested again by the same methods. The results of these tests are shown in the following table.

Portions of the Tract	Immediate Reaction	Reaction End of 24 hrs.
Oesophagi	7.0	7.0
Honey stomachs + Stomachs	5.6	5.6
Intestine	7.4	7.4
Neutral Water	7.0	7.0

The second tests were made to see whether the solutions could stand in a cool room 24 hrs. without affecting their reactions. This point is very important, for in making the solubility tests the arsenate of lead was acted upon for 24 hrs. If during this time there was an increase in the acidity or alkalinity due to the decomposition of the tissues, then the solubility would be greater than under normal conditions and so give misleading results. As the table shows there was no change in the Ph + at the end of the 24 hrs.

Solubility Tests

In making the solubility tests, twenty bees were chloroformed, im-

mediately dissected and their alimentary tracts divided into three portions (oesophagi, honey stomachs plus stomachs, and intestines) and each of the portions was placed in 20 c.c. of neutral water. To each flask of water plus its portion of the digestive tracts, was added exactly one gram of arsenate of lead powder, and to 20 c.c. of neutral water alone was also added one gram of the same powder. This last flask was, of course, used as a check. At this point in the experiment, the writer had the choice of two procedures. In the first place, the portions of the alimentary tracts could have been washed for several hours in the neutral water, then filtered off and the arsenate of lead added to the filtrate. The second way was to add the arsenate of lead immediately to the water plus its portions of the alimentary tracts. Both ways have their merits and faults. In adding the arsenate to the filtrates there is the possibility of obtaining not only a solution of the digestive fluids but also, because the portions of the alimentary tracts would have to stand several hours in the neutral water before filtering, the chance of getting into the filtrate the products of cellular decomposition that would effect the results by increasing the solubility of the poison. The second method in which the arsenate is added immediately would prevent the formation of decomposition products for arsenic in the body acts as a preservative. This point has been noted by many writers who have performed autopsies on arsenically poisoned animals.

One bad feature of this latter procedure is that the cells undoubtedly absorb some of the soluble arsenic. The arsenic then, very likely, becomes bound up with the protoplasm itself and so does not pass into the filtrate. In other words the filtrate obtained does not contain the total amount of arsenic rendered soluble by the digestive fluids.

While it was true that the Ph + did not change when the portions stood 24 hrs., the writer chose the latter method in order to feel sure that the arsenate of lead was not being acted upon by the products of putrefaction.

The contents of the flasks were agitated several times, then at the end of 24 hrs. were filtered. The check was treated in the same manner. In filtering, a triple filter was made using Schlucher and Schüle No. 589, 11 cm. paper. The filtrates were re-filtered eight times in order that they should contain nothing but the soluble arsenic i. e., to prevent any undissolved arsenate of lead powder from passing into the final filtrates.

To the four final filtrates, namely, from the three portions of the alimentary tract and the check, was added 5 c.c. of concentrated nitric

acid. This was done in the case of the samples from the alimentary tract to destroy any soluble organic matter that might have passed through the filter paper and which would later hinder the arsenic determinations. It was added to the check to allow for the possibility of arsenic being introduced through the nitric acid itself. After the acid was added the filtrates were evaporated to dryness on a steam bath.

When all the samples had been evaporated to dryness, they were redissolved in 100 c.c. of concentrated HCl, that is to say, 100 c.c. of HCl was added to each sample and also to the check. From this point the standard method for total arsenic determination was employed. In a 500 c.c. distilling flask there was placed 6 grams of cuprous chloride. Then, through a separatory funnel, the 100 c.c. of HCl containing the sample was added and the liquid distilled down to 50 c.c. The flask containing the sample was washed with three more portions of concentrated HCl-50 c. c. in each portion—and these were distilled over after the original 100 c. c. had distilled down to 50 c. c. The final distillate for each sample was 200 c. c., 50 c. c. being left in the distilling flask. The distillate was caught in three flasks packed in ice and the receiving flasks were carefully washed into a large flask so that none of the distilled liquid was lost. Of course, the same procedure was carried on for all three samples and the check. The four distillates were then made up to 1,000 c. c. each, then filtered, and finally made up into 100 c. c. aliquots. The aliquots were neutralized with sodium bicarbonate and to each aliquot was added a small amount, 2 c.c., of starch paste as an indicator. Then the aliquots were titrated against iodine and as soon as a permanent, but faint, blue color was obtained, the quantity of iodine needed to bring about this result was determined. The results of the titration were as follows.

Oesophagus aliquot	No. 1—.11 c. c.
"	No. 2—.10 c. c.
"	No. 3—.11 c. c.
Honey Stomach plus Stomach aliquot	No. 1—.13 c. c.
"	No. 2—.12 c. c.
"	No. 3—.13 c. c.
Intestine aliquot	No. 1—.29 c. c.
"	No. 2—.30 c. c.
"	No. 3—.30 c. c.
Check (water sol.) aliquot	No. 1—.11 c. c.
"	No. 2—.11 c. c.

A blank was also distilled over. This consisted of 250 c. c. of concentrated HCl and 6 grams of cuprous chloride. By distilling over 200 c. c. of this blank, the writer was able to determine the arsenic

present in the reagents. Titrating aliquots of this blank, the results were as follows.—

Blank aliquot. . . . . No. 1—.04 c. c.
" No. 2—.04 c. c.

The final determinations were:—

Oesophagus	.11	c. c.	minus	.04	c. c.	(blank)	=.07 c. c.	final	reading
H. Stomach + Stomach	.13	"	"	"	"	"	=.09 c. c.	"	"
Intestine	.30	"	"	"	"	"	=.26 c. c.	"	"
Check	.11	"	"	"	"	"	=.07 c. c.	"	"

The next step was to take a standard solution of soluble arsenic and titrate with the same iodine. When this was done, it was found that it took 41.01 c. c. of iodine to neutralize 25 c. c. of this standard solution. Twenty-five c. c. of the standard solution was known to contain .025 grams of As_2O_3, so one cubic centimeter of iodine would neutralize $\frac{.025}{41.01}$ or .000609607 g. of As_2O_3. To find the grams of As_2 multiply the As_2O_3 factor by .75748 and for As_2O_5 multiply the same factor by 1.-16168. These factors are based on atomic weights. The final factor for As_2 determination was .00046176511036 grams As_2 for every c.c. of iodine used (.000609607 $\times$ .75748) and the grams of As_2O_5 neutralized by every c.c. of iodine was equal to .00070816825976 (.000609607 $\times$ 1.16168).

Having made these determinations they were then used in computing the As_2 and As_2O_5 present in the samples and check. These computations were as follows:—

Oesophagus

.07 c. c. iodine $\times$ .000461765 = .0000323255 grams As_2 in an aliquot

.07 c. c. iodine $\times$ .0007081682 = .000049571774 grams As_2O_5 in an aliquot

Honey Stomach plus Stomach

.09 c. c. iodine $\times$ .000461765 = .00004155885 grams As_2 in an aliquot

.09 c. c. iodine $\times$ .0007081682 = .0000637335138 grams As_2O_5 in an aliquot

Intestine

.26 c. c. iodine $\times$ .000461765 = .0001200589 grams As_2 in an aliquot

.26 c. c. iodine $\times$ .0007081682 = .000184123732 grams As_2O_5 in an aliquot

Check

.07 c. c. iodine $\times$ .000461765 = .0000323255 grams As_2 in an aliquot

.07 c. c. iodine $\times$ .0007081682 = .000049571774 grams As_2O_5 in an aliquot

Since each aliquot was 1/10 of the total amount (100 c. c. of 1,000 c. c.) these results must be multiplied by ten to get the number of grams of As_2 and As_2O_5 rendered soluble by the digestive fluids and the water check. If we wish to reduce the quantities to per cents it is necessary to

divide again by 100 as one gram of powder was introduced into each flask. The final table of solubilities would therefore be:

Oesophagus
  As_2—.0003232+ grams or .032%
  As_2O_5—.0004957+ grams or .049%
Honey Stomach and Stomach
  As_2—.0004155+ grams or .041%
  As_2O_5—.0006373+ grams or .063%
Intestine
  As_2—.0012005+ grams or .12%
  As_2O_5—.0018412+ grams or .184%
Check
  As_2—.0003232+ grams or .032%
  As_2O_5—.0004957+ grams or .049%
    Check (water sol.)

Since the quantities are so minute they are well within the limits of possible error, and must be taken as mere indications of the effect of digestive fluids upon arsenate of lead powder rather than looking upon them as absolutely accurate or fixed quantities. For this reason it would be better to express the solubilities with reference to the water soluble arsenate of lead. Taking this as a unit we have

Check (water sol.)
  As_2—.032% =1.00
  As_2O_5—.049% =1.00
Oesophagus
  As_2—.032% =1.00
  As_2O_5—.049% =−1.00
Honey Stomach and Stomach
  As_2—.041 =1.28
  As_2O_5—.063 =1.28
Intestine
  As_2—.120% =3.75
  As_2O_5—.184% =3.75

Summary

1. The hydrogen ion concentration of the alimentary tract of the honey bee is as follows:—oesophagus 7.0 (?), stomach plus the honey stomach 5.6, and intestine 7.4.

2. The results of this experiment can only be an indication of what goes on in the insect's body, for in carrying out this work some of the soluble arsenic combined with the cell protoplasm and could not be found in the filtrate. Furthermore, natural conditions could not be simulated so that it is probable that even more arsenic would be rendered soluble by the living insect.

3. Accepting these qualifications we find that the digestive fluids of the oesophagus apparently do not render the arsenate of lead more soluble. (Further investigation should be carried on here). Secondly the digestive fluids of the honey stomach and stomach makes the powder 1.28 times as soluble as it would be in water alone. Thirdly the intestinal fluids increase the solubility 3.75 times what it would be in pure water.

ACKNOWLEDGMENTS

In carrying out this work the writer received many helpful suggestions and material aid from several persons. It was through Prof. Bourne that the writer was able to obtain specimens for dissection. The determination of hydrogen ion concentration by the electrical method was made by Dr. Itano using an apparatus devised by himself. For a fuller description of this device see Bulletin 167 of the Mass. Agricultural Experiment Station on the "Relation of Hydrogen Ion Concentration of Media to the Proteolytic Activity of Bacillus subtilis" by Arao Itano, January 1916.

Dr. Holland kindly granted the use of the experiment station and both he and Mr. Dunbar demonstrated to the writer the methods employed in arsenic determination.

Miss Emma Oetinger very kindly prepared the manuscript for publication.

To all these persons the writer wishes to express his sincerest gratitude.

RESULTS SECURED FROM LATE SEASON APPLICATIONS OF CALCIUM ARSENATE DUST, FOR THE CONTROL OF THE COTTON BOLL WEEVIL

By C. B. NICKELS, *Clemson College, S. C.*

ABSTRACT

The cotton boll weevil (*Anthonomus grandis* Boh.) causes severe damage to late fruiting crops after the beginning of migration. Serious injury did not occur in majority of fields until August 10th or later.

The average increase in yield of seed cotton resulting from the use of calcium arsenate dust on comparable plots was 236 pounds per acre. Average expense of using the calcium arsenate dust method was the cost of 29.27 pounds of calcium arsenate and 3.6 hours of labor.

The experiments discussed in this publication were conducted in the Piedmont Section of South Carolina during 1923. During the season of 1922, also 1923, a high percentage of the injury caused by the weevil,

occurred either within two weeks before migration or after the beginning of migration.

FACTORS INFLUENCING TESTS.—Serious weevil infestation did not occur in the majority of the plots until August 10th, or later. It was necessary to poison only one field used in these tests prior to August 9th. Several plots selected to be used in these tests never required poisoning because the crop matured before weevil injury developed.

The number of poison applications required is determined by the percentage of infestation and the fruiting condition of plants. No applications of poison were made when weevil infestation was low or when the plants were not fruiting.

Cotton on fertile land that continued fruiting over a long period, offered the best opportunity for securing increase in yield, as a result of poisoning. The crop was late in localities, where tests were conducted, affording an excellent opportunity for testing the value of poison applications after the beginning of weevil migration.

SEASONAL PROGRESS OF INFESTATION.—Infestation records were made weekly, throughout the growing season. Before square formation the weevil infestation was determined by counts of the number of weevils per hundred plants. After square formation the weevil infestation was determined by counting the percentage of squares infested. A summary of these records is given in tables 1 and 2. The plots used in these experiments varied in size from three-quarters of an acre to 3½ acres, no poison applications having been made on these plots, prior to the date records were begun. It is believed that these records will indicate, why early poisoning did not usually give profitable results in the localities under consideration.

TABLE 1. PLANT INFESTATION RECORDS

Date	Percentage	Number of Plots examined
June 12	1.19	11
June 18	0.9538	21
June 25	1.23	21
July 3	0.9966	12
July 9	0.7012	8

TABLE 2. SQUARE INFESTATION RECORDS

Date	Percentage	Number of Plots examined
July 9	4.823	7
July 16	3.937	28
July 24	2.876	29
August 1	3.467	24
August 8	2.382	29
August 15	17.656	20
August 22	24.296	13

Thirty-eight plots received no treatment for weevil control prior to August 10th and only four plots developed sufficient infestation to require control methods before that date. Some of the plots from which records are given in the above tables, were used as checks in sweetened poison and proprietary mixture tests.

Table 3, is a record of the percentage of square or bud infestation of the calcium arsenate dust plots.

TABLE 3. SQUARE INFESTATION

Plat No.	July 16	July 24	August 2	August 7	August 15	August 22	August 29	Sept. 6
1	7	11	5	14	33	11	17	28
1 Check	11	8	19	19	54	79	92	100
2	3	1	1	1	4	6	2	5
2 C.	2	1	1	7	8	25	35	71
3		1	6	11	19	13	43	
3 C.		4	7	13	36	52	86	
4	4	1	0	3	7	9	11	
4 C.	5	1	0	5	6	16	42	
5	6	2		2	14	26	13	33
5, 6 C.	2	3		6	20	22	15	74
6	1	3		4	6	11	17	27
7	5	3	1	2	16	5	11	25
7 C.	5	6	1	12	26	30	31	100

RECORDS MADE TO DETERMINE UNIFORMITY OF PLANT GROWTH.—Methods developed by the Delta Laboratory of the Bureau of Entomology were used. Detailed records were made at frequent intervals, but those records are too voluminous to be given here.

POISON APPLICATIONS.—Applications of poison were always made, when there was dew on the plants, usually between the hours of 4–7:30 A. M. Hand dusters and two row traction dusters were used in making applications.

Table 4, gives the dates of poison applications, the quantity of poison used and the labor required.

TABLE 4. POISON APPLICATIONS

Plat No.	Date Applications July	August	Sept.	Total Lbs. Poison	Total Hrs. Labor
1	28	3 11 15 21 25 31		27.72	4.7
2		13 20 25		24.	3.
3		10 15 21 25 29		36.55	5.
4		25 31	5 11	34.24	3.85
5		20 25 30	10	25.84	4.
6		20 25 30	10	23.	4.
7		13 20 25 30		25.88	3.66

REDUCTION IN SQUARE INFESTATION.—Results secured from the use

of calcium arsenate dust and the percentage of square infested, after the beginning of poisoning.

TABLE 5.

Date	Infestation Poisoned	No. Plots	Infestation Check	No. Plots	Poison Reduction
Aug. 2.......	5.5 %	1	18.8 %	1	13.3 %
Aug. 7.......	14.	1	19.3	1	5.3
Aug. 15......	15.57	7	27.71	5	12.14
Aug. 22......	9.24	11	34.48	7	25.24
Aug. 29......	13.03	13	47.67	8	34.64
Sept. 6.......	21.66	8	80.14	5	58.48

The percentage of increase in bloom production of poison plots over checks is shown in table 6.

TABLE 6.

Plat No.	August 13	15	22	29	Sept. 4	8
1		49	291	508	504	
2	11		32	59	313	
3		17	78	460	643	
4			13		45	
5				61		125
6			33	43		125
7		97	88			210

YIELD.—The production of seed cotton on comparable plots is given in table 7.

TABLE 7.

Plat No.	Yield Lbs. Seed Cotton per Acre. Check	Poisoned	Increase Lbs. Seed cotton over check
1	338	541	203
3	581	726	145
4	724	1085	361
5	1019	1406	387
6	1019	1195	176
7	699	845	146

The average increase in yield was 24.45 percent or 236 pounds of seed cotton per acre.

THE IMPORTANCE OF THE FLAXSEED COUNT IN PREDICTING THE ACTUAL FLY-FREE-DATE

By C. J. DRAKE, F. A. FENTON and F. D. BUTCHER, *Ames, Iowa*

ABSTRACT

The period of emergence of either the fall or spring brood of Hessian flies, *Phytophaga destructor* Say, varies from year to year with bioclimatic conditions. On this account "fixed" or "approved" dates are unreliable and the seeding date each year should be correlated with the season and with the fall brood of flies. In Iowa, the

flaxseed count has been the only constant and reliable factor to use in predicting accurately the actual fly-free-date. One hundred or more flaxseeds were collected at each station each day (average about 1,000 per day at Monona county station) from old stubble dug up at random in heavily infested fields. These flaxseeds were then classified as parasitized, empty and viable. The viable flaxseeds were then dissected to determine the per cent of larvae, of pupae and of parasitized larvae. Hence, the flaxseed count gave the daily rate of transformation from the larva to the pupa and to the adult state, as well as the rate of approach of the fly-free-date. When this count yields very few pupae and only a small per cent of larvae in contrast to a large number of empty flaxseeds, it is proof that the actual fly-free-date is at hand and that the few remaining pupae will immediately issue as flies, lay their eggs and perish before wheat drilled at this time will come up. Thus it is possible to predict the fly-free-date so that farmers can begin drilling wheat six or seven days before the end of the egg laying period of the fall brood of flies. The records of the Iowa Observation Stations for 1922 and 1923 are given in the form of a summary.

On account of the importance of the wheat crop to man, probably no insect pest has received more attention or has ever had more said or written about it and its depredations than the Hessian fly,[1] the principal field enemy of the young-growing wheat plant. For many decades it has been a well-known fact that there was a safe date (short period) to sow winter wheat and also, at the same time, to produce a maximum yield. The solution of the problem of *predicting the fly-free-date* has been a perplexing one for years.

Seeding late to avoid Hessian fly damage was recommended by many of the earliest writers. This general recommendation was followed by the "fixed" fly-free-date method. The latter method, based largely on altitude, longitude, latitude and an average of previous safe-sowing records, proved satisfactory in "average" or "normal" years. Frequently, however, farmers who scrupulously followed these "approved" or "fixed" dates suffered heavy losses. While the theory of late planting is good, the fallacy of setting a fixed or static safe-date is evident when it is known that the period of the emergence of either the spring or the fall brood varies from year to year with climatic conditions.

In spite of seeding wheat on the proposed safe dates, the Hessian fly has been a serious pest in the Mississippi Valley during the past few years. These outbreaks brought out forcibly the fact that the "fixed" seeding dates are unreliable and that each year the seeding date should be correlated with the season and with the fall brood of the flies. As a result, several changes have been made in methods for determining the fly-free-date. Field studies carried on in Ohio by Gossard and Parks disclosed the fact that the fly-free-date varies considerably from year to

[1]*Phytophaga destructor* Say; family Cecidomyiidae; order *Diptera*.

year for a given locality. Their daily records also showed the wavering appearance of the flies and the egg-laying records of the fall brood.

Predicting the Actual Fly-Free-Date

On account of the extremely fluctuating emergence of the flies in the field and in the concentration boxes, together with the rate of egg-laying on the young wheat plants, the writers found the flax-seed[2] count to be the only constant and reliable factor to use in *predicting* the *actual* fly-free-date. This daily count determined the exact percentage of flies emerged, parasitized, as well as those in the larval and pupal stages. Moreover, when the count showed very few pupae and only a small per cent of larvae in contrast to a large number of empty flax-seeds, it was proof that the *actual* fly-free-date was at hand, and that the few flies yet to emerge would issue, lay their eggs and perish before wheat drilled at this time would come up.

Iowa Observation Station Records[3]

Monona County station, Onawa, 1922:—A total of 19,225 eggs were laid on the 100 marked wheat plants during the 25-day emergence period of the fall brood from September 10 to October 4, an average of 769 per day. From the two concentration cages 13,926 flies issued and 1,156 were caught on the migration screen. The crest of the brood occurred September 29 (Fig. 12), on which day the actual fly-free-date was announced. In 1923, conditions were radically different at this station. When the observations were started September 5, flax-seed counts showed that about 31 per cent of the puparia were viable, the rest having emerged as flies or parasites. This year, 1923, a total of 7,150 eggs were laid on the 100 plants during a 19-day period, an average of 375.7 per day; 477 flies issued in the concentration boxes and 182 were caught on the migration screen. The heaviest recorded egg deposition occurred between September 10 and 18, being interrupted by a rain and a four-day period of cool weather (Fig. 13). Seventeen and five tenths per cent of the puparia issued as parasites and 28 per cent of the holdover larvae were parasitized. The fly-free-date for this county, 1923, was announced on September 25, four days earlier than in the preceding year.

[2]The flax-seeds were taken from old wheat stubble dug up each day at random in the field. The puparia were classified as parasitized, emerged and viable. The latter were then opened to determine the per cent of larvae, pupae and unemerged parasites.

[3]For further details see Ia. Agr. Exp. Sta. Cir. 86, 1923.

Page County station, Essex, 1922:—A total of 2,897 eggs were deposited on 100 plants during a 24-day emergence period of the fall brood from September 16 to October 9, an average of 120.7 eggs per day. From the two concentration cages 1,619 flies emerged, and 1,060 were caught on the migration screen. The peak of the emergence was reached Cctober 1 and the actual fly-free-date, based on flaxseed counts, was announced October 3. Six days later the egg laying period for the fall brood was over. The fly-free-date for this county was also announced on this same date in 1923.

Mills county station, Imogene, 1923:—A total of 12,918 eggs were laid on 100 plants, during the 32-day emergence period from September 8 to October 9, an average of 403.6 per day. From the two concentration cages 2,877 flies issued and 520 were caught on the migration screen. The crest of the brood was reached September 29 (Fig. 14). The actual

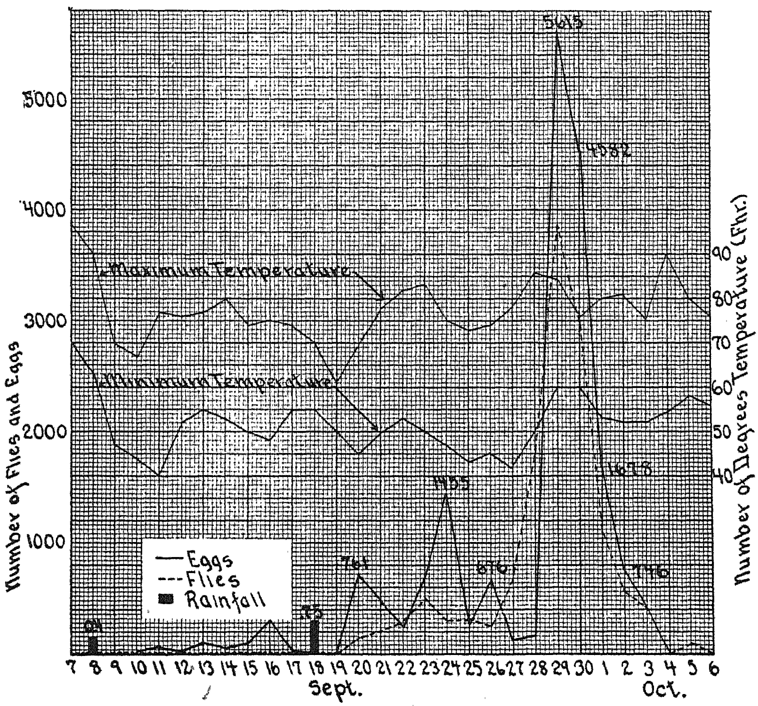


FIG. 12. Graph showing daily egg and fly records at the Monona County District Station, Onawa, 1922

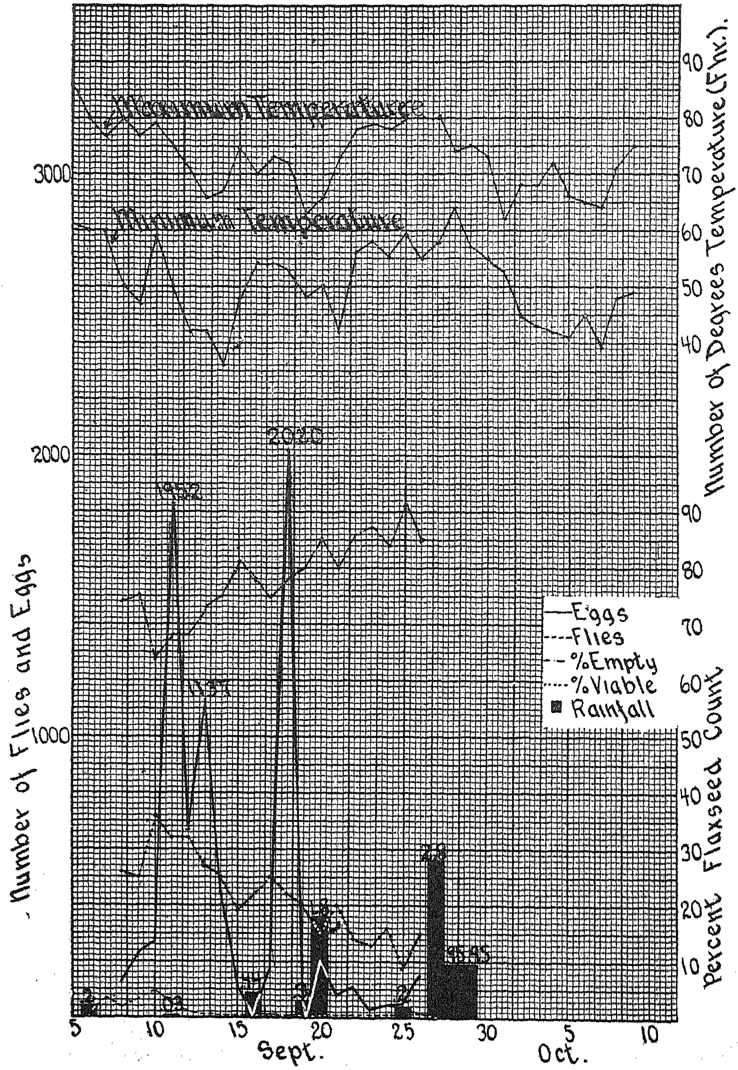


FIG. 13. Graph showing daily egg, fly and flax-seed records at the Monona County District Station, Onawa, 1923

fly-free-date was announced October 2, seven days before the fall brood had entirely disappeared.

Appanoose county station, Udell, 1923:—A total of 9,005 eggs were

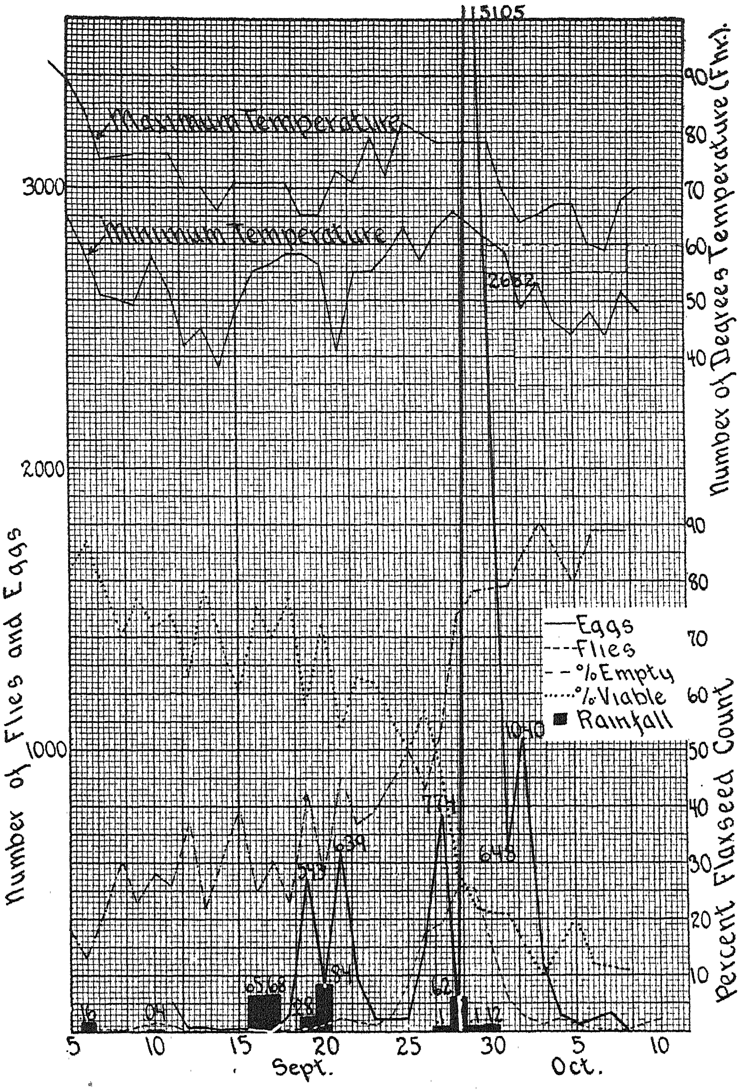


FIG. 14. Graph showing daily egg, fly and flaxseed records at the Mills County District Station, Imogene, 1923

laid on the 100 wheat plants during the 27-day emergence period from September 8 to October 4, an average of 333.5 per day. From the two concentration cages 645 flies issued and 664 were caught on the migration

screen. The peak of the brood was reached September 21 (Fig. 13), and the fly-free-date was announced October 3.

Warren county station, Spring Hill, 1922:—A total of 9,166 eggs were laid on the 100 wheat plants during a 29-day emergence period from September 8 to October 6, an average of 316 per day. From the two concentration cages 1,804 flies issued, and 524 were caught on the migration screen. The crest of the brood occurred September 23, but a second heavy egg deposition took place October 1. The fly-free-date was announced September 30, seven days before the fall emergence was over. In this county there were only 12 wheat fields drilled before the fly-free-date in 1922. Some of these were so badly infested that they were ploughed up in the spring of 1923. As a result of such excellent cooperation the Hessian fly was reduced in numbers far below the danger point for the whole county. In 1923 the station was located at Indianola. Only 193 flies emerged from the concentration cages during a 26-day period from September 8 to October 3, and 92 were caught on the migration screen, while only 16 eggs were laid on the 100 plants. The peak of the brood was reached September 25, and the actual fly-free-date was announced September 29. According to the county agent and crop reporters, the Hessian fly cost Warren County in 1922, between \$125,000 and \$150,000. In 1923 no injury was observed in the fields drilled on or after the actual fly-free-date, but a tax of about \$750 is charged against the fly in the 12 fields drilled too early. The farmers in this county and several others were so convinced of the accuracy of the flaxseed count in predicting the actual fly-free-date that no wheat was drilled until the safe date was announced in 1923.

REARING FLIES FOR EXPERIMENTAL PURPOSES WITH BIOLOGICAL NOTES

By R. W. Glaser, Sc.D., *Department of Animal Pathology of the Rockefeller Institute for Medical Research, Princeton, N. J.*

Abstract

The house fly (*Musca domestica*), the biting stable fly (*Stomoxys calcitrans*), and the cattle horn fly (*Lyperosia irritans*) were used extensively in studies on the transmission of microorganisms by these insects. During the course of these studies simple, inexpensive and effective methods have been evolved for the rearing and handling of large numbers of flies. Special emphasis is placed on a type of breeding jar, on adult fly foods, on temperature, and on humidity. It was found that the last three have an important bearing on longevity and reproduction. To keep adult house flies alive long enough to obtain the full development of their ovaries and testes it is

necessary to feed them sugar or assimilable starch, together with a solution of proteins or products of protein hydrolysis. In regard to the food for adult *Stomoxys*, the use of defibrinated cow or horse blood warmed to a temperature of 35–37°C. proved to be satisfactory for this form. This procedure facilitates the omission of living higher animals as a source of blood for the flies. A number of minor biological and life-history observations are included in the article.

The article was written for investigators who use flies for disease, genetic, physiological or other biological researches.

I. Introduction

During the past four years the writer has reared large numbers of three species of flies for use in studying certain problems dealing with the relation of bacteria to these insects. These studies necessitated the development of simple, inexpensive and effective technical methods for rearing and handling large numbers of flies under experimental conditions and it is hoped that the present paper will give other investigators, interested in this phase of entomology, an opportunity to profit by or to elaborate upon and modify the experiences encountered.

So many biologists have reared flies for use in dealing with disease, genetic, physiological and other researches that it is difficult to distinguish between what is technically old and new. Much credit is due to such investigators as Howard, Jepson, Hewitt, Bacot, Graham-Smith, Bishopp and others, and the present paper does not in any way wish to minimize or overlook that which has been already accomplished. The methods of various investigators are scattered throughout a host of books, journals and bulletins which are not all readily accessible to any one individual. However, the writer feels that he has absorbed most of the important methods described, has modified these to meet other needs, and has introduced new links in the chain wherever this was considered advantageous.

Musca domestica L., *Stomoxys calcitrans* L., and *Lyperosia irritans* Rob.-Desv. were the three species bred and handled. Certain procedures that are generally applicable to these will be first explained. This will be followed by separate descriptions of procedures applicable only to a single species.

2. General Methods

To start new cultures wild flies are caught around stables while sitting or feeding on horses and cattle, or while resting on the walls and sides of the stalls. They are best caught by means of small, straight phials such as shown in the illustration given on Plate 10, Figure 4. The open phial is moved very slowly and steadily towards the resting or

feeding fly until approximately ½ inch from the insect's dorsal surface when a sudden, quick movement will span the remaining distance and capture the quarry. By using one phial as a storing bottle and another as a catching one, several flies may be transferred to the storing phial. This is accomplished by taking advantage of the flies' positive heliotropic reponses. The means used for transferring living insects from one phial or bottle to another is too well known to deserve further comment. If two or three dozen phials are used, aprpoximately one hundred flies may be caught during the course of an hour, provided they are plentiful. This method of catching the insects is simpler and preferable to the use of nets and traps; injury to the flies is avoided, one can nearly always instantly determine which species or sex is being caught, and with a little practice one can obtain a larger number of the desired flies in a shorter while than in any other way known. The phials may also be washed and sterilized should this be desirable.

On starting a new culture early in the spring when the adults are first appearing and the gonads are still undeveloped, it is necessary to capture both sexes and feed them about two weeks in order to produce a sufficient number of fertile eggs. Later in the season only females with swollen abdomens should be taken. These are usually fertile and ready for oviposition on a favorable medium. Indeed, very often gravid females will oviposit in the collecting bottles.

The newly captured flies may now be transferred to the breeding jar. A type of jar devised, which proved highly satisfactory, is shown on Plate 9, Figure 1. It consists of an ordinary battery jar with a wooden top which is covered with a No. 20 mesh (400 meshes to the square inch), copper wire gauze. The center of the top is perforated by a hole one inch in diameter and just large enough to insert the opening of a collecting phial. In making the hole, the one-inch diameter auger is replaced by a three-fourth-inch diameter one when three-quarters of the distance has been bored. This forms a narrow shelf upon which the collecting phial may rest. The reverse side of the top is shown on Plate 9, Figure 2. It will be seen that the entire top is cut from one piece of wood. The grooves for fitting the top to the battery jar are also shown at the junction of the central support and the rim of the top. Since the diameter of the tops and jars vary slightly it is difficult to obtain a close fit. This can be corrected by making a paper collar as shown in Figure 1. About one-fourth to one-third of a jar is filled with the larval medium (horse manure, fermenting straw, or cow dung) packed loosely with a wooden stick and moistened slightly with water.

The paper collar and top are now fitted and a cork inserted into the opening.

The captured wild flies are now introduced. This is effected by taking the corks out of the breeding jar and phials and by inserting the latter into the opening of the breeding jar top. By darkening or by shaking the phials a little, the transfers can be made quickly. Except when wild flies are caught early in the spring, the adults need not be fed. The females readily lay their eggs on the medium and development soon follows. During the entire life cycle the temperature and humidity of the rearing room must be watched. The temperature should not fall much below 25°C., and 30°C. seems to be very favorable. The atmosphere must not become dry. In the summer it is possible to ventilate extensively and the outside air (in New Jersey) maintains the proper humidity within, but when cold weather arrives and it is necessary to resort to artificial heat, water should be evaporated constantly, otherwise the breeding medium will rapidly dry out and become hard, especially in the upper layers. The medium must further be moistened from above every few days, but great care should be taken not to add too much water so as to avoid drowning the maggots in the lower part of the jar. With a little practice the necessary absorbing capacity of the medium for water can be readily determined.

The first generation of reared adults will usually emerge during a period of several days. This is very convenient for the experimenter, because if the entire brood issued on one day it would be very difficult to utilize all the material to the best advantage. The adults are extracted by the method shown on Plate I, Figure 3. The breeding jar is darkened with a black cotton bag having a draw string at the open end so that it may be closed tightly around the edges of the breeding top hole. The cork is now taken out of the breeding jar top and a wide-mouthed, six-ounce bottle is quickly placed over the opening. This type of bottle is large enough to hold many flies and is also flanged, so that the insects do not easily slide back into the jar when once extracted. By substituting empty bottles every little while, by shaking the whole outfit, by gently tapping on the top, and by permitting either sunlight or artificial light to shine from above, all the flies may be extracted in a short while. The three species used are positively heliotrophic when they first emerge and are hungry, but notwithstanding this fact, they vary somewhat in the rapidity of their responses to light, for instance, *Lyperosia* and *Stomoxys* react very quickly, on the other hand, the house fly responds more slowly and will often become negatively heliotrophic after its preliminary

positive response. To keep them from wandering back into the darkened jar after emerging into the light, it is necessary to transfer the emerged individuals into stock bottles as soon as this can be accomplished conveniently.

After a sufficient number of flies have been taken out, they may be studied and used for certain experiments. This is best done by etherizing[1] the insects. Care must be taken not to bring the liquid ether in direct contact with the flies, otherwise, they will not recover. The stock bottle is held towards the light for a moment, in order to drive the flies to the far end, it is then opened and a sufficient amount of ether dropped on the cork. The flies soon become etherized and may be kept in a state of light anesthesia for from ten to fifteen minutes. During this time they may be counted, identified as to species and sex, or studied further. After these procedures, the mass of flies may be used in whole or in part for experiments, or they may be used to start a fresh brood.

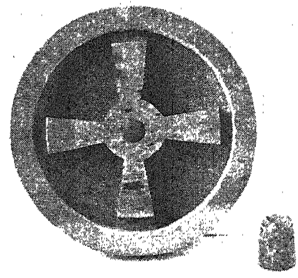
If the insects are to be used for breeding purposes, approximately an even number of both sexes are transferred to a fresh breeding jar previously sterilized[2] and prepared with the medium. They are fed for the first time after complete recovery from the anesthesia, but the writer has found that flies will not take much food until the day following this treatment. In order to obtain a large crop the succeeding generation, feeding must be practiced for about two weeks or until the majority of the females are seen to be ovipositing. In general, it has been the practice at this laboratory to cease feeding the adults when newly hatched maggots are seen to be working within the medium. After the feeding is stopped the adults soon die or they may be extracted and killed.

The best types of food for the adult flies will be described later under the sections dealing with the individual species. Certain conditions of the food and method of feeding are, however, applicable to the three species. All food is prepared under sterile conditions and is stored on ice in bottles or test tubes until used. With the exception of lump sucrose, employed as one of the essentials for house flies, all foods are in a liquid or semi-liquid state, and are warmed to about 37°C. or 38°C. before using. By means of sterile pipettes drops of the food are deposited over the entire surface of the wire gauze top of the breeding jar. Three large drops deposited in each spot are usually sufficient to permit part of

[1]Chloroform kills many insects even when lightly administered.

[2]Between broods the jars, tops and corks must be cleaned, scrubbed and sterilized. The sterilization is practiced for the reason that otherwise bacteria pathogenic to flies may be transferred from one brood to another.

1.



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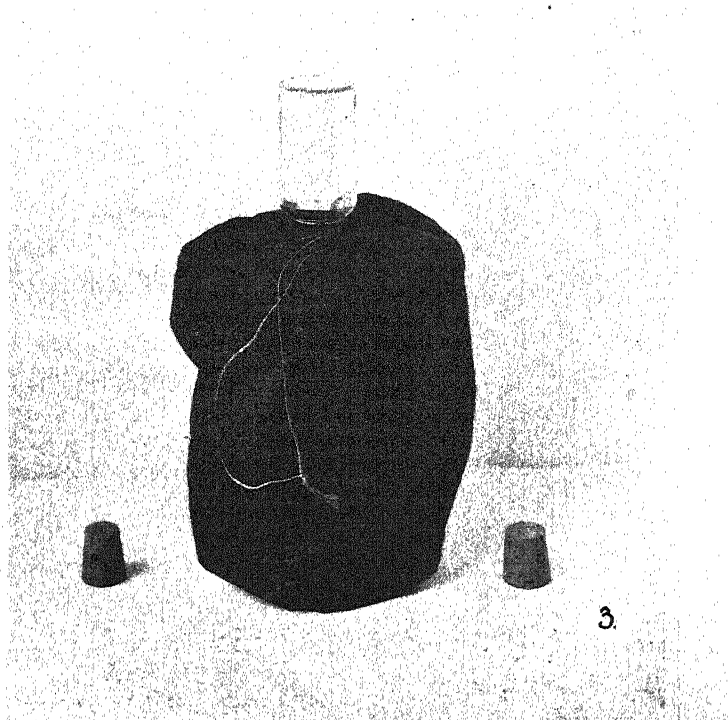

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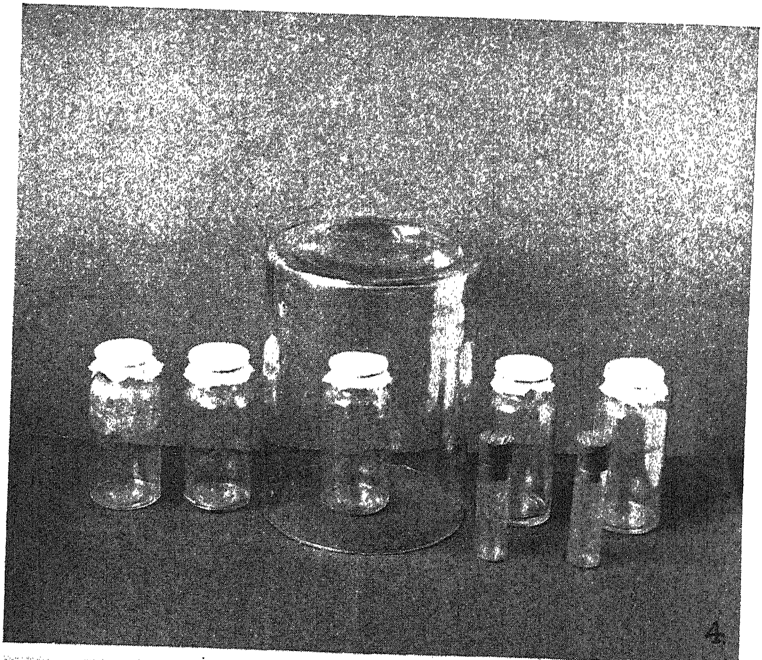
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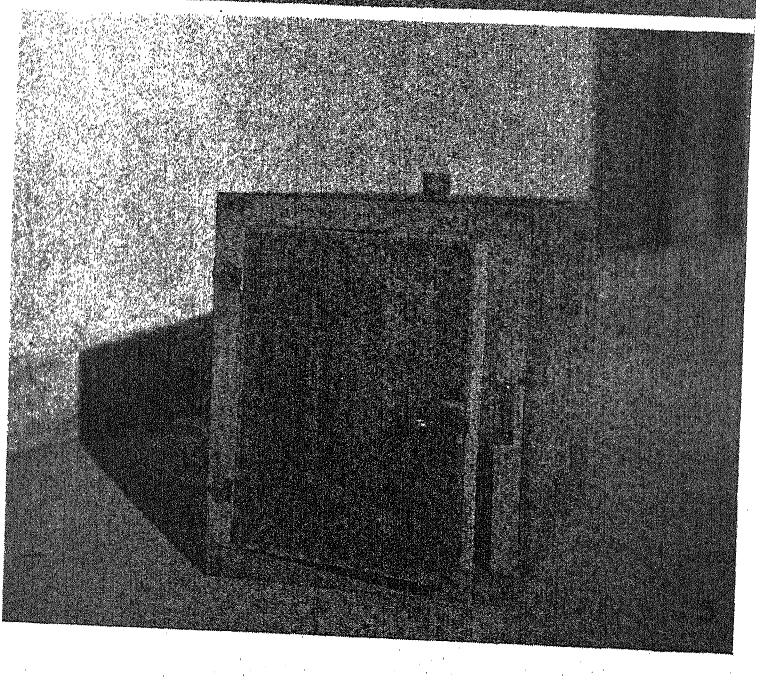

the liquid to hang down on the reverse side of the top. This, naturally, is a great aid to the flies in obtaining a sufficient amount of food. The food is tendered for about 15 to 20 minutes. During this time all flies requiring food will have fed. The remaining fluid is then absorbed with absorbent paper towels and the tops (left in place) are scrubbed with hot water by means of a stiff hand brush.

If a new brood of adults is to be used for study instead of breeding, individuals may be isolated or a certain number of one sex or of both sexes segregated. For this purpose the wide-mouthed, six-ounce bottles shown on Plate II, Figure 4 are employed and a breeding medium may be first introduced should this be desirable. The transfers from the breeding jar are effected as previously described and the desired flies placed in the experimental bottles while under anesthesia. Cotton gauze tops held in place by rubber bands keep the flies from escaping. A bell or battery jar, as shown in the figure, may also be placed over the bottles to keep wild stray flies from contaminating the tops.

The flies in the experimental bottles are fed by permitting the liquid or semi-liquid food to drop upon the cotton gauze tops from pipettes. Three drops from an ordinary pipette are usually sufficient for from six to twelve flies. The third drop usually falls through, which is a good thing, since two or three individuals in a bottle always seem to prefer to take their food at the bottom instead of at the gauze top. Feeding, engorgement with the consequent tremendous swelling of the abdomen, and the passage of feces later are all indications that the food offered has been accepted.

As a matter of routine, the flies subjected to experimentation were transferred to fresh sterile bottles three times a week and fresh tops replaced the old ones. However, if a particular bottle became unduly soiled the flies were transferred to a fresh bottle as soon as the condition was noticed. It is important to watch the bottles, because flies become soiled easily with liquid or semi-liquid food, especially when old and weak. When in this condition they frequently stick to the glass where they die of hunger or exhaustion. When found in this predicament and still alive, they can be saved by removing them with a pair of blunt forceps and washing them off under a gentle stream of lukewarm water from the tap. In most cases flies so treated will recover and appear normal the next day.

Experience in using both the experimental bottles and the breeding jars has shown that it is necessary to feed adult flies daily without exception. No advantage is gained by feeding *M. domestica* or *Stomoxys*

more than once a day, but *Lyperosia irritans* must be provided with fresh food twice daily, in the morning and in the evening. Unless this rule is adhered to rigidly the worker will obtain an unduly high starvation mortality which will seriously interfere with his experiments.

Two species of flies, namely, *M. domestica* and *Stomoxys calcitrans*, have been reared by the writer from approximately the middle of April until the middle of December. The artificial conditions (artificial heat, food, etc.) seem to manifest their influence at this time, however, for it has so far been impossible to rear these flies during the remaining four months of the year.

The cage shown on Plate 10, Figure 5, was devised for use in feeding blood-sucking flies on small laboratory animals such as rabbits and guinea pigs. The wire gauze is the same mesh as that used for the breeding jar tops and will not permit the passage of a small fly like *Lyperosia irritans*. The cork closing the hole for introducing and extracting the flies is shown on the top of the cage. When flies are extrated the cage is enveloped in a black cotton bag. The hair of most laboratory animals is very long and must be clipped in places so that the flies can feed. It is also often desirable to shave the skin over small areas. Due to the discomfort experienced by having the skin punctured by many flies, it is advisable not to expose the animals, at any one time, for more than a few minutes.

3. Special Features

Besides giving a few special technical hints in this section, the writer has also found it necessary to add a number of biological observations. This is not meant to include a detailed account of the life history of flies as this has already been accomplished by others. One cannot, however, work with a group of animals for any great length of time without noticing a few things that appear new and have been overlooked.

M. domestica L.

House flies have been reared by the writer from the middle of April until the middle of December. At this time the last generation of adult flies oviposited, but the progeny died either in the larval or in the pupal stage. These cultures were comprised of bred flies in the fifth and sixth generation. Whether the mortality of the cultures was due to the cumulative effect of the artificial conditions under which they were reared or not, it is at present difficult to conclude. It does not, however, seem to be simply a freak occurrence appearing only a single time. Three cultures in 1924 abruptly concluded their development in the manner described.

Fermenting bran and hay, horse manure, and other materials were used for a larval medium, but the horse manure was selected as the best and most practical. This must always be obtained in a perfectly fresh condition, so as to exlude the possibility of ovipositions by wild flies. Unless a culture is started with wild adults early in the spring, the probability is that the preoviposition period and fertilization have been completed and feeding of the wild flies may be omittted. The females soon seek holes or crevices between particles of manure and crawl into these if possible. The ovipositor is then extended and periodically undergoes contractive movements which expel the eggs. The time of the hatching of the larvae varies with the temperature. At 30°C. or 35°C., the larvae will hatch within twelve hours after oviposition; if below 30°C., it may take twenty-four hours, and if below 20°C., hatching may be postponed for a few days. According to Hewitt (1) "there are three larval stages or instars, the larva moulting twice during the course of its development." This author gives the following most probable minimum time of duration for each of the stages from egg to adult: egg stage, 8 hours; 1st instar, 1 day; 2nd instar, 1 day; 3d instar, 3 days; pupal stage, 3 days; making the total minimum period from egg to adult 8 days, 8 hours. Under certain experimental conditions Hewitt was able to obtain as short a record as 8 days, 4 hours, but he states that this is probably exceptional and that "it is unlikely that in the hottest weather development would be accomplished in less than nine days. These minimum periods are the result of a large series of experiments in which it was a more common occurrence to have a batch of larvae developing in ten, fifteen or twenty days." The writer was able to verify Hewitt's observations and obtain 13 to 19 days as the time required from egg to adult under temperature conditions varying from 20°C.–35°C.

The total durations given above, it must be explained, are those from egg to adult and not from adult to adult. The preoviposition period, or the period between emergence from the pupal case and the full development of the adult male and female reproductive organs followed by fertilization, is an important phase in the life of these insects. This phase in the life history can only be accurately determined by breeding flies for a number of generations.

In 1923 the writer (2) showed that certain types of food are important longevity and reproductive factors for adult flies. To keep adult house flies alive long enough to obtain the full development of their ovaries and testes it is necessary to feed them sugar or assimilable

starch, together with a solution of proteins or products of protein hydrolysis. These materials may be given in the form of lump sucrose dropped into the breeding jar or semi-liquid starch paste dropped on the cover. This must be supplemented with nutrient bouillon, blood serum or egg white. Milk alone is also an efficient food on account of the fact that it contains the two factors mentioned in the form of lactose and casein.

On the foods mentioned the longevity of the adult *M. domestica* varies from 2 to 57 days, with an arithmetical mean of 20 + days. During this time the ovaries and testes develop and eggs are deposited in from 11 to 24 days with an arithmetical mean of 15 days.

The sex ratios of all the cultures, whether from first generation flies obtained from wild females or from inbred material, showed certain slight variations, but in general the sexes are equal numerically. An effect on the sex ratio, that could be directly and safely attributed to climatic conditions or to a special type of food was not obtained.

Stomoxys calcitrans L.

The biting stable flies have been reared by the writer from April 22 to December 7. After this time the cultures automatically "died out" as with the house flies.

Fermenting oat straw alone, horse manure alone, and a mixture of the two were extensively used for a larval medium. As a matter of routine, pure horse manure was finally adopted as the best and most practical medium. The cultures are prepared in the manner described for *M. domestica.*

The life history of *Stomoxys calcitrans* has been very fully and accurately described by Newstead (3) in 1906, and by Bishopp (4, 5) in 1913 and 1920. It is very similar to that of the house fly. If wild gravid females are put in the breeding jars, they soon lay their eggs which hatch in from 1 to 3 days. According to Bishopp larval development takes 11 to 30 days or more, and the metamorphosis within the pupal case 6 to 20 days or longer depending on the temperature. Bishopp obtained 18 days as the minimum time and 53 or more days as the maximum time required for development from egg to adult.

The writer has noticed a somewhat greater effect of temperature on the rapidity of development in *Stomoxys* than in house flies. During very hot weather the cycle from egg to adult may be spanned in as short a time as 14 days, whereas cool spring or autumn days may prolong the period to 43 or more days.

To obtain the development of the ovaries and testes of bred *Stomoxys,*

in other words, to cover the time required for the preoviposition period, the insects were first fed directly on horses and cattle. This was effected by placing a number of newly emerged male and female flies in a wide-mouthed six-ounce bottle covered with cheesecloth and pressing the covered end firmly against the back or side of the host. The flies soon insert their mouth parts through the cheesecloth top and feed. This method of feeding biting flies is tedious, however, as the bottles must be held to the animals for at least a half hour to insure the engorgement of all the flies. When many flies are to be fed, it is almost impossible to do anything else during the course of the day. The horse or cow are partly restrained in stanchions during the operation but, nevertheless, often violently resent being punctured in one place by a dozen or more flies and this, of course, does not add to the simplicity of the procedure. Small fly cages attached to horses or cattle are of no value, for these are rubbed off as soon as the irritation caused by the feeding insects begins.

The use of small laboratory animals, by means of the cage previously described, next suggested itself. This method proved somewhat better, provided one is fortunate enough to acquire a phlegmatic guinea pig or rabbit. Most of these animals, however, become extremely nervous and active when attacked by flies and will usually not permit them to remain upon them long enough for complete engorgement.

It was found that reared *Stomoxys* engorge readily on defibrinated, whole horse or cow blood when the latter is warmed to a temperature of 35°C.–37°C. The blood is obtained under sterile conditions from the jugular vein of the animals, is defibrinated, and stored on ice until needed. A large enough amount to supply the needs for about two weeks is obtained at one time. On feeding, the serum and cellular elements are mixed with a pipette, the mixture warmed and dropped on the breeding jar or bottle covers.

When reared *Stomoxys*, in mixed sex cultures, are fed defibrinated blood they will oviposit from three to seven times and lay many eggs. These eggs hatch, develop and produce another generation of flies. Up to date five generations of *Stomoxys clacitrans* have been reared in this manner.

The longevity of reared adult *Stomoxys* thus fed varies from 3 to 46 days, with an arithmetical mean of 20 + days. The preoviposition period varies from 9 to 13 days, with an arithmetical mean of 10 + days.

The sexes of bred *Stomoxys* are approximately equal, with a slight preponderance of males. No effect on the sex ratio was noticed that

could be certainly and safely attributed to climatic condition or to food.

Lyperosia irritans Rob.-Desv.

The horn fly confines its attentions exclusively to cattle on which it remains day and night with the exception that at intervals females with mature eggs dart down to fresh deposited cow dung for the purpose of oviposition. Having accomplished this function, they return to the cow where they either feed again or rest.

When wild, gravid females are placed in breeding jars with fresh cow dung and fed defibrinated cow blood, some will remain alive for as long as 25 days, but cease laying eggs in from 3 to 5 days. The eggs hatch in 2 to 3 days, depending upon the temperature, and larval development follows. The minimum time required for a culture to complete its cycle from egg to adult was 11 days during an exceedingly hot wave in July. The maximum periods consumed during cooler weather were 20 days in May and 22 days in October.

The first generation of reared *Lyperosia*, artificially fed, live from 1 to 24 days, but lay no eggs. For this reason it has not been possible to rear this fly beyond the first generation of adults.

In a previous publication (2) the matter of the resistance of *Lyperosia* to propagation under experimental conditions is discussed, after many attempts were made to induce the development of the reproductive organs of the first generation of reared males and females. It is difficult to conclude whether the food, the treatment, or both were responsible for this behavior.

In concluding the subject of *Lyperosia irritans* it might be well to state that the sexes of the first generation of reared adults are numerically equal.

Summary

Simple, inexpensive and effective methods of rearing and handling large numbers of flies have been described in this article. A number of observations on the biology of *Musca domestica*, *Stomoxys calcitrans* and *Lyperosia irritans* are likewise included.

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PARASITISM OF SCALES—SAN JOSE AND OYSTER SHELL

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ABSTRACT

The San Jose scale, *Aspidiotus perniciosus* Comst., and occasionally the Oyster Shell scale, *Lepidosaphes ulmi* L., are serious pests in many fruit growing districts. Parasites often play an important role in reducing these scales.

In order to determine what species of parasites were present, samples of infested twigs were collected from several regions and the following species of parasites were bred: From San Jose scale—*Prospaltella perniciosi* Tow., *Aphelinus fuscipennis* How., *Aphelinus mytilaspidis* LeB., *Signiphora pulchra* Gir., *Perissopterus* sp., and *Ablerus clisiocampae* Ashm.; from Oyster Shell scale—*Aphelinus mytilaspidis* LeB.

During the last few years the San Jose scale (*Aspidiotus perniciosus* Comst.) has attracted considerable attention in many important fruit growing districts. It has multiplied in such enormous numbers as to cause alarm among orchardists. In some of the more heavily infested districts many hundreds of trees were killed or badly injured before the seriousness of the situation was fully realized and effective spraying measures brought into play.

In connection with the study of the scale problem it was thought desirable to ascertain the parasites present. With this in view ten lots of twigs infested with the San Jose scale and one lot infested with the oyster-shell scale (*Lepidosaphes ulmi* Linn.) were received at the Sligo, Md., laboratory in late August and early September of 1922. The twigs were securely wrapped in waxed paper and upon receipt were at once placed in glass test tubes stopped with cotton. The parasites soon commenced to emerge, the total period of emergence extending for about three weeks.

An examination of the parasites showed the presence of six species[1] from the San Jose scale and one from the oyster-shell scale. One of the species, *Aphelinus mytilaspidis* LeB., was common to both of the scales.

In table I, will be found a list of all the parasites that emerged and the number of each.

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[1]Determined by Mr. A. B. Gahan of the U. S. Bureau of Entomology, Wash., D. C.

TABLE 1. PARASITES OF THE SAN JOSE SCALE

Place collected and collector	Host	Parasites: Aphelinus mytilaspidis LeB.	Aphelinus fuscipennis How.	Prospaltella perniciosi Tow.	Ablerus clisiocampae Ashm.	Signiphora pulchra Gir.	Perissopterus sp.
Fort Valley, Ga. O. I. Snapp	Peach	0	0	0	0	0	0
Aurora, Ill. C. C. Compton	Apple	0	0	39	0	0	2
Unknown Unknown	Apple	0	0	0	0	0	0
San Pierre, Ind. J. J. Davis	Apple	0	0	1	0	0	0
Lafayette, Ind. J. J. Davis	Apple	18	17	512	1	8	0
Bicknell, Ind. (1) J. J. Davis	Apple	0	4	85	0	0	1
Bicknell, Ind. (2) J. J. Culver	Apple	0	0	24	0	0	0
Washington, Ind. J. J. Davis	Apple	0	0	14	0	0	0
Bentonville, Ark. A. J. Ackerman	Apple	0	0	471	0	0	0
Geneva, N. Y. Geneva Exp. Sta.	Apple	0	2	50	0	0	0
Total........		18	23	1196	1	8	3
PARASITES OF THE OYSTER SHELL SCALE							
Aurora, Ill. C. C. Compton	Apple	99	0	0	0	0	0

An examination of Table 1 will show that of the parasites emerging from the San Jose scale only one species, *Prospaltella perniciosi* Tow., was present in any appreciable number or in a majority of the localities from which twigs were received. In the case of the oyster shell scale only one species, *Aphelinus mytilaspidis* LeB., emerged.

In order to determine the degree or amount of parasitism it was necessary to make a count of the scales on the twigs and in this count all male and very immature female scales were omitted. No account was taken of the probability that a number of parasites died within the host.

In Table 2 will be found the number and length of the twigs, the number of scales, the number of parasites and the per cent of parasitism for each locality from which twigs were received.

TABLE 2. SAN JOSE SCALE—PARASITISM

Place collected	Emerged at Sligo, Md.	Number of twigs	Ave. length of twigs in inches	Number of scales	Number of parasites	Per cent of parasitism
Fort Valley, Ga.	Sept. 1922	11	4.60	7446	0	0.00
Aurora, Ill.	Sept. 1922	5	6.05	3217	41	1.27
Unknown	Sept. 1922	6	6.62	12028	0	0.00
San Pierre, Ind.	Nov. 1922	1	6.50	1456	1	0.07
Lafayette, Ind.	Sept. 1922	5	6.40	9249	556	6.01
Bicknell, Ind. (1)	Sept. 1922	22	4.81	15790	90	0.57
Bicknell, Ind. (2)	Sept. 1922	11	5.41	10436	24	0.23
Washington, Ind.	Sept. 1922	5	6.33	4614	14	0.30
Bentonville, Ark.	Sept. 1922	19	4.35	25108	471	1.88
Geneva, N. Y.	Sept. 1922	12	6.07	3077	52	1.69
	OYSTER SHELL SCALE—PARASITISM					
Aurora, Ill.	Sept. 1922	37	2.87	4591	99	2.16

An examination of Table 2 will show the per cent of parasitism as based on these samples to vary from 0.00 for the scales from Fort Valley, Ga., and an unknown locality to 6.01 for the scales from Lafayette, Ind.

FURTHER STUDIES OF DERRIS AS AN INSECTICIDE

By E. R. DE ONG and L. T. W. WHITE, *University of California.*

Extracts of Derris have been commonly reported as a valuable insecticide, the species when mentioned usually being *D. elliptica* (common name "Tuba"), the "derris" of commerce. There are forty or more species of this genus, at least twelve of which are found in the Philippine Islands. Insecticidal tests have been made with the following species by Mr. H. E. Woodworth, formerly of the College of Agriculture, University of the Philippines, Los Banos, to whom I am indebted for the following data, on species abundant in the Phillippine Islands.

SCIENTIFIC NAME	PARTS USED	DILUTION OF SOLUTION	REMARKS
Derris elliptica	stem	20%	negative
	young shoot	20%	negative
	root	20%	positive
Derris philippinensis	leaves	20%	negative
	stem	1%	positive
	stem (boiled)	20%	negative
	roots	20%	positive

Derris sp.	leaves	20%	negative
	stem	20%	positive
	flowers	10%	negative
	leaves (boiled)	20%	negative

Derris polyantha (common name "Tugle," "Malagogon-dapo") is reported by Foxworthy and Elmer in "The Flora of Makùng and its Vicinity" to contain a fish poison in its bark.

Many species of Derris in the Philippines are rank-growing vines, found in such abundance on the mountain sides that they would probably furnish a continuous supply of the raw material at a medium cost of harvesting.

The following experiments in extraction and insecticidal tests were made with the ground root of *Derris* sp. diluted with calcium carbonate and with commercial liquid and dust preparations. Four extracts were prepared from dried roots of *Derris* sp. (probably *elliptica*) using as solvents, petroleum ether, ether, alcohol and water. The ether extracts were of a yellowish brown structure, brittle at room temperature and soluble in some of the alcohols. The alcoholic extract was of a gummy nature and the water extract flaky. Pyridine was found to be the most satisfactory solvent for all the extracts except the alcoholic, which was soluble in both ethyl and methyl alcohol. From this it would seem that an alcoholic extract dissolved in wood alcohol would be an economical commercial preparation, or an ether extract dissolved in pyridine. Variations from these results might be found with different species of Derris.

Tests of the susceptibility of the guinea-pig to Derris extracts were made by sub-cutaneous, abdominal injections with the following results:

(a) One-fourth cc. of a solution made by dissolving .002 gm. pure petroleum-ether extract dissolved in one-half cc. of pyridine,—no pathological symptoms.

(b) One-fourth cc. of .103 gm. ether extract dissolved in one-half cc. of pyridine,—symptoms: rapid irregular heart action, loss of appetite and weight for three days followed by a rapid return to normality.

This indicates a very slight susceptibility to the action of Derris, since even the smaller amount was much in excess of that which would be absorbed by light dustings.

The commercial extract of sixteen per cent concentration diluted 1 to 500 gave a 13% control on *Aphis nerii* Fons., and a 50% control on the green peach aphid (*Rhopalosiphum persicae* Sulzer). Dilutions of 1 to 300 gave a maximum control of 68% on the latter species of aphid and 25% on the red spider (*Tetranychus telarius* Linn.). Dilu-

tions of the same concentrate at 1 to 500 added to mosquito infested water killed 65% of the larvae but had no effect on the pupae. The powdered derris root (undiluted) sprinkled on the surface of the water killed 90 per cent of the larvae in two to four hours. The same powder when dusted on aphids gave a 100% efficiency in eight hours and a 98% control of the larvae of *Euphydryas chalcedona* when dusted on the leaves upon which they were feeding. From these experiments it is judged that the active principle "derris" is both a stomach and a "respiratory" or tracheal poison. The reaction on the caterpillars must have resulted from ingestion of the powder, since fumigating tests with the material gave negative results, while the fumigating action of the commercial derris extract was close to that of the toxicity curve for spraying. A check test on pyridine as a fumigant gave an efficiency of three and eight-tenths per cent.

Tests on Animal Parasites

Powdered derris root diluted to a twenty per cent concentration with calcium carbonate, as well as the commercial derris dusts, gave perfect control on the chicken lice (*Menopon biseriatum* Prag. and *Gonicotis gigas* Tasch.) and the Giropid lice (*Gyropus ovalis* Nitzsch and *Gliricola porcelli Linn.*) on the guinea-pig. The control of lice on large numbers of guinea-pigs is often a perplexing problem, especially in research work where perfect normality is desired for all experimental animals. Lice are especially difficult to control on young pigs and brood sows; the former often showing a high mortality. Powdered derris at twenty per cent dilution has given good satisfaction to the veterinarians at the University of California for this type of work, the powdered derris being applied to the birds by the pinch method of dusting on the infested areas. On the pigs, the powder was rubbed into the fur over the entire body or in treating pregnant sows the dust was applied behind the ears and on the back.

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Scientific Notes

A Pecan Case-bearer. During the past winter considerable numbers of various varieties of pecans have been introduced into widely separated parts of California. With the advent of spring and the leafing out of the trees it has been found that those trees that were introduced from Monticello, Florida were quite heavily infested with a leaf case-bearer, which seems to be *Acrobasis nebulella* Riley. The County Horticultural Commissioners are taking steps to eradicate the pest before it becomes established, as some fear is felt that it might attack English walnuts, of which there are large plantings. Adults were noted to be emerging during the second week of June. CLIFFORD T. DODDS

An Infestation of *Autographa biloba* Steph. on Lettuce. Early in June an outbreak of caterpillars causing extensive defoliation of lettuce in a cold frame was noted at A & M College, Mississippi. Both the caterpillars and cocoons closely resembled those of *Autographa brassicae*, but since this species though always abundant in this section on cabbage and closely related cruciferous crops, rarely if ever becomes a pest on lettuce, it was suspected that another species was involved. Specimens of larvae and cocoons were collected and reared, the adult being determined by Mr. F. H. Benjamin of Decatur, Illinois as *Autographa biloba* Steph.

The damage by this species to the lettuce in the cold frame was complete, the defoliation approaching one hundred per cent. Lettuce in the garden outside the frame, less than one hundred feet distant from it, remained untouched. No other infestation has been seen in the locality, and although all the pupae in the insectary have emerged there has been up to the time of writing (July 5th) no recurrence of infestation on the location of the original infestation.

Twenty specimens were taken to the insectary. Twelve of these emerged, and six succumbed to a malady having the characteristic appearance of a polyhedral disease. One of the six was examined and found to contain great numbers of the polyhedral bodies typical of this type of disease. No parasites were reared.

H. W. ALLEN, *Mississippi Agricultural Experiment Station*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $3.00 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

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The West Coast entomologists are to be congratulated upon the first issue of "The Pan-Pacific Entomologist" just at hand. It is published quarterly by the Pacific Coast Entomological Society in cooperation with the California Academy of Sciences. It is primarily systematic and biological and rightly gives most attention to West Coast insects. There is a large field for this new journal and a corresponding opportunity for service. All economic entomologists are interested in this venture, not only on general principles but on account of the fact that all entomology is economic in its ultimate analysis. Any effort which assists in clearing up the unkown in relation to insect life, and there is still much of this, aids the more obvious economic investigations. Therefore, we welcome a new ally.

Factors affecting the distribution of insects have a very direct economic bearing. It is well known that the cotton moth and the large *Erebus odora* are found occasionally many miles north of their normal habitat—the swarms of fresh individuals of the former being most noteworthy. Some years ago the late Dr. J. B. Smith demonstrated the occurrence of salt marsh mosquitoes 40 miles from any known breeding places. The recovery of small gipsy moth larvae after drifting across Cape Cod Bay, some 20 miles, is another well known case. The widespread occurrence of insects with limited powers of flight, this latter being predicated upon frail bodies, such as those of gall midges and aphids, suggests that the lower air currents may play an important part

in carrying them. The extensive experiments with small balloons of a low buoyancy conducted by the New York State Conservation Commission in connection with the gipsy moth work, have demonstrated that long drifts, several hundred miles, are possible within 10 to 24 hours and that upward currents over heated areas may easily carry objects capable of floating in the air to heights of several thousand feet. The recovery of plant spores at 10,000 feet in the air is significant and the finding of grasshoppers at 1,000 feet above the surface and of mosquitoes at considerable elevations all tend to show that we know too little of insect movements, probably largely drifting, in the lower strata of the air. If man, the latest mammal to invade the air, can support himself in the ether for hours with a relatively crude glider, is it not reasonable to suppose that many insects, reared for aerial existence through countless generations, could do equally well and drift on the wings of the wind with slight muscular exertion. The rather common occurrence of many insects on high mountains, on glaciers and along the shores of bodies of water, all suggest that they may have been carried by winds and dropped by descending air currents likely to be found under such conditions. Air planes are being used for the distribution of poison. Could they not be employed occasionally for securing data on the vertical distribution of insects in the lower air strata? The swarms of aphids in late summer and early fall suggest air distribution. The cotton moth invites the attention of the aviator-entomologist.

Obituary

REGINALD CHARLES TREHERNE

Reginald Charles Treherne was born at Aldershott, England, on March 24, 1886. He died June 7, 1924, at Ottawa, Canada, from acute peritonitis. He was graduated from the Ontario Agricultural College and received the degree of Bachelor of Science in Agriculture from the University of Toronto in 1909. During the summer of 1908 he was employed in entomological investigations by the Louisiana State College and during the summer of 1909 was engaged in nursery inspection work in the Province of Ontario. In the same year he was appointed a field officer in the Dominion Entomological Service and for two years was engaged in investigations in the Provinces of New Brunswick and Ontario. In 1911 he was transferred to British Columbia, where he remained until 1922. He was promoted in 1915 to the position of Entomologist in Charge of Insect Investigation of British Columbia.

In 1919, when the Provincial and Federal entomological activities were coordinated, Mr. Treherne was given the general direction of the work. In 1921–1922, in addition to his duties as Provincial Entomologist, he lectured in Entomology in the University of British Columbia. His entomological investigations in British Columbia related to the bionomics and control of such important pests as the cabbage root maggot, the onion maggot, the strawberry root weevil, the pear thrips, the codling moth, the pear twig borer, and several species of grasshoppers destructive to crops grown on ranch lands. In all of this work Mr. Treherne attained leadership and a large part of the development of the Federal and Provincial entomological work in British Columbia is accredited to the organization perfected by him.

In 1922 Mr. Treherne was transferred to Ottawa and advanced to the position of Chief of the Division of Field Crops and Garden Insects of the Dominion of Canada. One of the first things he undertook in his new position was to inaugurate the Insect Pest Survey and the Insect Pest Record, both of which have been of real service to entomological workers. In spite of his pressing duties in directing economic entomological work, Mr. Treherne found time to devote considerable attention to the Thysanoptera, of which he was fast becoming a leading authority. He also took a keen interest in boys and only a few months before his death had become identified with a new movement in Canada known as the Rover Scout Movement.

Mr. Treherne was a member and an active worker in the following important scientific societies:

American Association of Economic Entomologists
Entomological Society of America
Ecological Society of America
Entomological Society of Ontario
Association of Economic Biology (England)
Fellow of the Entomological Society of London (England)

During his residence in British Columbia he was an active worker of the Entomological Society of British Columbia and its success during his residence in the Province was due largely to his efforts.

His earnest desire for economic entomology to develop on that broad and constructive plane so necessary for the rendering of the maximum service and usefulness was well illustrated by his leading part in the inauguration of and the participation in meetings of Entomologists engaged in similar entomological problems. This was particularly true in regard to entomological workers interested in the European corn

borer. His fine generosity and vision of professional service were largely instrumental in determining the practice of free interchange of plans of investigations and unpublished information on the European corn borer problem which has characterized the work in Canada and the United States from the first. The loss of his fellowship, experience, and resourcefulness is incalculable. In his untimely death Entomology has suffered a real loss, and his associates and co-workers in Canada and the United States will feel intimately the loss of his fine personality.

GEO. A. DEAN
F. C. CRAIGHEAD
J. E. GRAF

Current Notes

Mr. Alfred Lutken, Picayune, Miss., has resigned from the Bureau of Entomology.

Mr. A. L. Strand, assistant professor of entomological extension at Pennsylvania State College resigned to take effect April 15.

Mr. P. D. Sanders, M.S., University of Maryland, 1924, has been appointed Assistant Entomologist at the University of Maryland.

Mr. Henry Stabe, a graduate student in zoology and entomology at Iowa State College, has accepted an instructorship in entomology at Louisiana State University.

Mr. Geo. S. Langford, M.S., University of Maryland, 1924, has been appointed Deputy State Entomologist of Colorado, and assumed his new duties June 1st.

Professor George A. Dean and W. R. Walton visited Brooklyn, N. Y., May 22, to inspect the clean-up work being done there at the European corn borer infestation

President A. F. Burgess has just taken a month's trip to the Pacific coast, visiting a number of entomological departments and field stations on the way.

Doctor H. H. Knight of the University of Minnesota has accepted an assistant professorship in entomology at Iowa State College. He will begin work at Ames in September.

Mr. R. C. Burdette, a graduate of the University of Maryland in 1923, has been appointed to a graduate assistantship in the Department of Entomology of the University of Maryland.

According to *Science*, the Alexander Dyer MacGillivray collection of Tenthredinoidea has been purchased by the University of Illinois. The collection includes more than 400 types and about 1,000 species.

Professor Wallace Park who is in charge of the apiculture work at the University of Illinois is completing his work for a Doctor's degree at Iowa State College this summer.

Miss Pearl Anderson, Instructor in Zoology, University of Maryland, will go on half-time during the session of 1924–25, in order to take advanced work in the Department of Entomology.

Dr. F. C. Craighead, Bureau of Entomology, spent several days during May in

the vicinity of Asheville, N. C., examining southern pine beetle outbreaks and control work conducted during the previous winter.

Mr. William B. Turner, connected with the Bureau of Entomology for about fifteen years, and an associate member of the Association of Economic Entomologists, died at Sacramento, California, June 11, 1924.

Dr. N. E. Winters, head of the division of boll weevil control of the South Carolina Station has accepted an appointment with the division of cotton investigations of the Argentine Ministry of Agriculture.

According to the *Experiment Station Record*, H. A. Ballou is now professor of zoology and entomology at the Imperial College of Tropical Agriculture at St. Augustine, Trinidad, which was formally opened in October, 1922.

Mr. E. E. Russell, Bureau of Entomology, green bug and grasshopper investigations, Gainesville, Texas, has been transferred to Yuma, Ariz., to start an investigation of the alfalfa seed chalcid under direction of V. L. Wildermuth.

Messrs. H. L. Person and Albert Wagner have just completed a survey of the cut-over areas of the Sierra National Forest, to determine the extent to which insect losses are affecting the second crop of timber.

Prof. A. F. Conradi, State Entomologist of South Carolina, and a delegation from his State visited the peach insect laboratory of the Bureau of Entomology at Fort Valley, Ga., on May 20, to observe investigations under way.

Dr. J. D. Tothill returned to Canada from England on April 19. Shortly after his arrival, and accompanied by Mr. Simpson, a three weeks' trip was taken in the Nictau Lake district, investigating borer injury in fire-killed timber.

Entomological work and other work in Rhode Island is being held up or greatly handicapped because of the filibuster in the State Senate through which all appropriation bills and practically all other business is prevented from receiving consideration.

Prof. B. B. Fulton of the Oregon Agricultural Experiment Station and College has resigned to accept the position as Assistant Entomologist and instructor of entomology in the department of zoology and entomology at the Iowa State College. Professor Fulton began work at Ames July 15th.

Mr. E. Hargreaves of the Royal College of Science, South Kensington, London, formerly a Carnegie scholar who traveled and studied in the United States, has just been appointed entomologist in Sierra Leone. He planned to sail on June 11th.

Mr. Rodney Cecil, a graduate student in entomology at Iowa State College has accepted a position as Junior Entomologist with the Bureau of Entomology. He is working under the direction of Mr. Neale Howard in the Mexican Bean Beetle work at Birmingham, Ala.

Professor Ralph H. Smith closed his work in spreader research for the Golden State Milk Products Company (California Central Creameries) on June 1. He is now connected with the Department of Entomology, University of California, at Berkeley, where he should be addressed.

Mr. S. F. Potts, M.S., University of Maryland, 1924, has been appointed to a fellowship at Ohio State University, and during the summer will work on a temporary appointment in the Bureau of Entomology at the new Mexican Bean Beetle Laboratory in Ohio.

According to *Science*, Dr. William M. Wheeler, professor of entomology and dean of the faculty of the Bussey Institution at Harvard University, has been named to represent the University as exchange professor in France during the second half of the next college year.

Mr. Alan P. Dodd, who has been sent from Australia to take up the work on cactus insects recently relinquished by J. C. Hamlin, had a conference with the latter and Dr. W. D. Hunter at Tallulah, La., on May 20. He visited Washington later.

Entomological News announces the death of the following entomologists: Arthur Hugh Jones, English Lepidopterist, February 22, 1924; Herbert Campion, temporary assistant in Entomology, British Museum, January 24, 1924; Thomas A. Annandale, Director of the Zoological Survey of India, died at Calcutta, April 10, 1924.

Mr. Ivan L. Ressler, instructor in zoology and entomology at Iowa State College, has secured a leave of absence in order to complete his work for a Doctor's degree at the University of Pennsylvania. Mr. Ressler has a temporary instructorship in zoology in the University of Pennsylvania.

Recently the Dominion Entomologist arranged with the Director of the North-west Territories Branch of the Department of the Interior for collections of insects to be made by the Reverend Mr. Hoare in Arctic localities during the next two years. Mr. Hoare left for the north early in June.

Mr. Leonard S. McLaine, Chief of the Division of Foreign Pests Suppression of the Entomological Branch, Canadian Department of Agriculture, was married June 10, in St. Alban's Church, Ottawa, to Miss Kathleen Meredith Lett. Mr. and Mrs. McLaine sailed June 12 for a six weeks' trip in England.

Mr. N. F. Howard, Bureau of Entomology of Birmingham, Ala., recently visited Columbus and other points in Ohio, to prepare plans for the establishment of a new temporary substation at Columbus for the study of the Mexican bean beetle in its occurrence in Ohio. He also conferred with State and University officials.

The following appointments to the staff of the Canadian Entomological Branch have been announced: R. M. White, R. D. Bird, Treesbank; Walter Carter, H. E. Gray, Lethbridge; A. W. Woods, Strathroy; A. J. Graham, Vineland; T. Armstrong, G. A. Hammond, Hemmingford; E. A. Randall, Vernon, B. C.; N. A. Patterson, Annapolis Royal; G. S. Walley, H. H. Thomas, K. F. Auden, Morna Bonell.

A new project of the State Entomologists' office of Wisconsin is assistance to the state institutions in reducing insect losses. The State Board of Control has placed a trained agriculturist in charge of the farms and truck gardens at the seventeen state institutions and the staff of the state entomologist's office is making a survey of the premises at the different locations and arranging for improvements in insect control.

Mr. Louis A. Stearns, Associate Entomologist with the Virginia State Crop Pest Commission and Assistant Professor of Entomology at the Virginia Polytechnic Institute, Blacksburg, resigned his position April 1, to accept the position of Assistant Entomologist at the New Jersey Agricultural Experiment Station, New Brunswick, where he is continuing his investigation of the Oriental Peach Moth.

Messrs. K. L. Cockerham, of Biloxi, Miss., and S. C. Brummitt, of Silverhill, Ala., both of the Bureau of Entomology, recently met with the authorities of the Alabama State Board of Agriculture at Mobile, Ala., to formulate further plans for the future

conduct of the sweet-potato weevil eradication work in Alabama in co-operation with the above board.

Dr. Paul S. Welch was elected Editor of the Michigan Academy of Science, Arts and Letters at the twenty-ninth annual meeting held at Ann Arbor, April 2–4, 1924. Dr. Welch presented a paper on "Observations on the Early Larval Activities of *Nymphula macularis* (Lepidoptera)" and jointly with L. P. Wehrle, "A New Form of Acarinid Parasitism in Orthoptera."

According to the *Official Record*, a very large shipment of parasites of the Japanese Beetle has just been brought into this country on its way to the laboratory at Riverton, N. J. It weighed about 8,000 pounds, entered through the port of Seattle, and was shipped overland by parcel post to insure prompt movement at the lowest possible rate.

Dr. J. M. Aldrich left on May 31 for a two months' trip through the West. He will visit Kansas City and Atherton, Mo., San Francisco, Berkeley and Redlands, Calif., Portland, Ore., Pullman and Seattle, Wash., and other points, where he expects to do some collecting and consult with various specialists. He will also spend several weeks visiting relatives and friends.

Mr. J. E. Dudley, Bureau of Entomology, of Madison, Wis., has opened a branch laboratory for the summer at Columbus, Wis., where extensive tests will be conducted on the control of the pea aphis with various insecticides and the aphidozer which he designed last year. Any observations of particular interest on the pea aphis should be sent to Mr. Dudley, at Columbus.

Mr. S. A. Rohwer left Washington on May 28 for the purpose of investigating the practicability of introducing parasites into the forestry plantation at Halsey, Nebr., as a check on the ravages of the pine tip moth, *Evetria bushnelli*. This moth is causing severe damage to the pines on the reforestation project there. Mr. Rohwer will be absent for a month, or possibly more.

Mr. J. C. Hamlin, formerly employed by the Federal Horticultural Board, and more recently in charge of the entomological work for the Commonwealth Prickly Pear Board of Australia, was reinstated in the Bureau of Entomology on May 2, and assigned to duty at the Boll Weevil Laboratory at Tallulah, La. Mr. Hamlin is to give attention to the chemotropic responses of the boll weevil.

On May 14 and 15, Messrs. Plank, Whitcomb and Catchings of the Bureau of Entomology, with Ed. Foster, Collaborator of the Federal Horticultural Board, judged an exhibit of insects at New Orleans, in which two New Orleans Normal School classes and seven New Orleans grade schools competed for local prizes. These exhibits are held twice a year and a great deal of interest is shown in them by all the students.

Mr. Eric Watson, of Westacres, Pont Tail Road, England, appointed to the staff of the Entomological Branch, Canadian Department of Agriculture, as an Assistant Entomologist, reported for duty on April 14. Mr. Watson was born in Edinburgh, Scotland, and is a graduate of the Imperial College, London, England. He is making a systematic study of sawflies and will be glad to identify any material the field officers may care to send in.

Professor Harold R. Hagan, Salt Lake City, Utah, was elected First Vice President of the Utah Academy of Sciences at the seventeenth annual meeting held April 4–5,

1924, at the University of Utah, Salt Lake City. Professor Hagan was joint author of two papers presented at the meeting: "Embryonic Development of the Chinese Mantid," Harold R. Hagan and L. W. Sorenson: "Embryonic Development of the Telson of the Chinese Mantid," Harold R. Hagan and Miss Eva Hansen.

According to *Science*, the Northwest Association of Horticulturists, Entomologists and Plant Pathologists will hold its seventh annual meeting at Penticton, British Columbia, August 26–29, 1924. The membership of this association includes those interested in the three sciences in the States of Oregon, Washington, Idaho, Utah and Montana and in the province of British Columbia. The Pacific division of the American Phytopathological Society will also hold its annual meeting at the same time and place.

Recent appointments in the Bureau of Entomology have been announced as follows: B. S. Brown, Jr., field assistant at Fort Valley, Ga., curculio investigations; Basil E. Montgomery, Vincennes, Ind.; Rodney Cecil, Iowa State University, Mexican bean beetle investigations, Birmingham, Ala.; T. E. Bronson, field assistant, pea aphis investigations; Carleton Burnside, apicultural investigations; L. F. Greer, boll weevil laboratory; A. H. MacAndrews, forest insect investigations, Asheville, N. C.; E. J. Udine, grasshopper investigations, Billings, Mont.; John W. Nuttycombe, jointworm investigations, Charlottesville, Va.

At the thirty-fourth annual meeting of the Ohio Academy of Science, held at the Ohio State University, Columbus, April 18–19, 1924, papers were read by entomologists as follows: The Relation of Fish Production to Forestation, Raymond C. Osburn; Respiration in the Orthoptera, M. O. Lee; The Periodical Cicada in Ohio, H. A. Gossard; An Ohio Record for the Dragonfly (*Tachopteryx thoreyi*), James S. Hine; Ecologic Notes on Some Homoptera of the Southwest, Herbert Osborn; Some Practical and Theoretical Aspects of Lubricating Oil Emulsions as a Scalecide, L. L. Huber.

A meeting of entomologists, agronomists, railroad agricultural agents, and others interested in insect control in the southwestern winter wheat area, was held at Kansas City, Mo., May 24. A uniform plan for chinch bug control in the states of Iowa, Nebraska, Kansas, Missouri and Oklahoma was adopted and a committee was appointed to draft a similar program for Hessian fly control. Entomologists in attendance were: M. H. Swenk, H. B. Hungerford, J. R. Horton, C. J. Drake, I. L. Ressler, E. G. Kelly, J. W. McColloch, Otis Wade, L. Haseman, K. C. Sullivan, C. E. Sanborn, A. F. Satterthwait, Wm. Moore and V. I. Safro.

During the first part of May a preliminary examination of the proposed forest insect control project in the Missoula National Forest was made by J. C. Evenden and Elers Koch, Assistant District Forester, District 1. This project calls for a line of defense against the heavy epidemic of the mountain pine beetle, which threatens the valuable lodge-pole pine stands of the Deerlodge and southern Missoula National Forests. At the present time H. J. Rust, Entomological Ranger of this station, is marking the trees that are to be treated, and it is expected that control work will be started by May 22.

Dr. S. A. Graham, of the Lake States Forest Experiment Station, and Dr. S. B. Fracker, state entomologist of Wisconsin, made a survey through the jack pine growing areas of Wisconsin in June looking up insect infestations. It was found that the jack pine sawfly, which is locally injurious in certain other pine areas of the

Lake States, does not seem to be causing any damage in Wisconsin this season. It was also discovered that the pine tussock moth (*Olene leucophoea*) of which there was a serious outbreak in Burnett and Bayfield counties in 1922, seems to have been completely cleaned up for the present, at least, by natural enemies and disease.

Mr. Arthur Gibson, Dominion Entomologist of Canada, attended the annual meeting of the Quebec Society for the Protection of Plants, which was held at Macdonald College, during the third week of April. During the evening session he gave a brief account of a recent hearing which he attended in Washington, D. C., regarding the movement of Christmas Trees from the Quebec Province into the United States and showed maps indicating the area in Quebec Province upon which the Federal Horticultural Board has placed an embargo. He also spoke of the recent infestation of the gipsy moth found at Alburg, Vermont. During the following day he went to Montreal and spent a short time with the inspection officers at that port.

Mr. C. H. Curran, who has been connected with the Division of Systematic Entomology, Entomological Branch, Canadian Department of Agriculture, as Assistant Entomologist, for the past year and a half, relinquished his position on April first on promotion to the position of Entomologist in Charge of Stored Products Insect Investigations, formerly held by Mr. E. H. Strickland. Mr. Curran will continue in charge of the Diptera in the Canadian National Collection, in addition to the work entailed in his new duties. He proposes to complete as far as possible the collection of insects attacking stored products and will also take up the study of mites, especially those groups whose members are of economic importance. Mr. Curran spent his holidays during the latter part of March and early April at Cornell University, studying the Diptera in the collection. Arrangements were made for the exchange of specimens with the Canadian National Collection.

At the invitation of Samuel Henshaw and Nathan Banks of the Cambridge Museum of Comparative Zoology, and Professors W. M. Wheeler and C. T. Brues, of Bussey Institute, Dr. E. A. Schwarz, accompanied by R. C. Shannon, went for several days to Cambridge and Boston. At the Cambridge Museum, Dr. Schwarz made an examination of the Coleoptera collections of Le Conte, Melsheimer, Ziegler, and others, and helped Mr. Banks elucidate a number of tangles existing among the various labels on the specimens, and clear up other points relating to type specimens. Mr. Shannon studied the types in the Osten Sacken-Loew collection. The Entomological Society of Cambridge had a special meeting, a smoker, in honor of Dr. Schwarz. Here he met a number of his old friends and many new entomologists who are now members of this club. C. W. Collins took Dr. Schwarz for a visit to the Gipsy Moth Laboratory at Melrose Highlands, where he met the personnel and was shown the different phases of their work.

Horticultural Inspection Notes

Mr. P. A. Glick has been transferred from New York to Washington, where he will be located permanently.

Mr. Charles E. Prince, Jr., has received a temporary appointment in the Plant Quarantine Inspection Service and is stationed at New York City.

Mr. Napoleon Beaudoin, B.S.A., was recently appointed to the position of Insect Pest Investigator for the Montreal Inspection Staff, and reported for duty May 16.

Mr. L. R. Gagnon, B.S.A., graduate of Ste. Anne de la Pocatiere Agricultural

College, has been appointed as District Inspector on the Montreal Staff and reported for duty March 25.

A Fruit Fly taken from a fruit of the Mango, originating in Costa Rica and intercepted at Boston, Mass., has been identified by Dr. Aldrich as *Anastrepha distans* Hender., a rare species.

Fly larvae taken from the fruit of Sapodilla from Dominica, British West Indies, and intercepted at New York city on May 7, 1924, were identified by Mr. C. T. Greene as *Anastrepha serpentina* Wied.

A disease commonly known as Citrus Canker was found on oranges intercepted in the baggage of a passenger arriving at Seattle from Japan. The interception was made by Mr. E. I. Smith on June 16, 1924.

Mr. W. A. Fowler has recently been appointed to the position of District Inspector in the Toronto district and in addition to being responsible for the inspection of imported and exported nursery stock in that territory, will also maintain the enforcement of the corn borer quarantine.

Mr. W. St. G. Ryan, who has been on the staff of the Canadian Entomological Branch for two years and transferred from Toronto to Montreal last fall as acting officer in charge, was appointed to the permanent position of Junior Entomologist in charge of the Port from April 1st.

Dr. C. L. Marlatt left Washington on June the 20th to attend the Pan-Pacific Food Conservation Conference, in session at Honolulu from July 31st to August 14th inclusive. While in the Hawaiian Islands, Dr. Marlatt will investigate the Fruit Fly situation in the Islands and confer with the Inspection force on matters relating to Plant Quarantine Inspection.

An examination of seed cotton used as packing for cotton-gin saw bands being shipped by mail from Mexico to Alabama, was made at Nogales, Arizona. Weevils taken from the shipment were identified by Dr. E. A. Schwarz as *Anthonomus grandis* Boh., apparently of the typical form.

The inspectors of the Federal Horticultural Board, while examining a shipment of grapes at New York City arriving from the Argentine Republic, intercepted a Coccinellid which was identified by Dr. Schwarz as *Epilachna paenulata* Germ. Dr. Schwarz commented as follows: "This is one of the phytophagous species of Coccinellidae the introduction of which into the United States is by no means desirable."

Mr. R. W. Sheppard, who has had considerable training in biology, in England, and who was employed last season on Corn Borer work, has been appointed permanent District Inspector at the Canadian Port of Niagara Falls. Mr. Sheppard was stationed at this port in a temporary capacity during the fall and winter months.

Mr. Ralph A. Sheals, Assistant Entomologist in Rhode Island, spent a period of approximately six weeks in March, April and May in St. Louis and Kansas City inspecting nursery stock in transit from the Eastern United States to the Rocky Mountain and Pacific Coast States. This work is being carried on in connection with the effort to check the spread of white pine blister rust.

The headquarters staff of the Canadian Entomological Branch was rushed continually through the winter and spring in connection with the issuance of permits for nursery stock importations and related work. The entry of many prohibited plants was checked by means of the permit system and it is felt that a very satisfactory check

is obtained on all nursery stock entering Canada and especially from Europe. A total of 4,653 permits had been issued for United States shipments on May 12, and 2,563 permits for importations from other countries. The value of the nursery stock examined by the inspectors between March 24 and May 12 was approximately $135,000.00.

Dr. Hunter has reported that in the inspection of automobiles in inter-state traffic from New Mexico to Arizona during a period of about seventeen months, from November 24, 1922, to April 29, 1924, a total of 31,006 cars were inspected. The inspections resulted in the interception of 2,975 cotton sacks, 94 lots of cotton carried as souvenirs, 327 mattresses and pillows stuffed with cotton, 2,221 Citrus fruits, 327 lots of cotton seed and seed cotton, and 578 lots of other contraband material. Numerous specimens of larvae and adults of the Boll Weevil were found in confiscated materials and on May 16, 1924, two living specimens of the Pink Boll worm were found in a sack of cotton being carried to California.

Dr. S. B. Fracker has reported as follows in regard to the inspection of automobiles carrying trees and shrubs within the State: "Under a co-operative arrangement with the state Conservation commission, the conservation and game wardens of Wisconsin are deputized by the State Department of Agriculture to assist the state entomologist in preventing general violations of the nursery inspection law. Like that of most states, the Wisconsin statute prohibits the transporting of uninspected trees and shrubs for propagation. The transporting of material of this kind for long distances bid not often occur until about 1922 when tourist traffic increased enormously. During the summer of 1923 the wardens and nursery inspectors intercepted 657 autos carrying trees and shrubs. Detailed reports were made on 57 of these cases. It was found that 39 of these were destined for points within the state and 18 for outside points. Fourteen of the 57 autos were carrying White Pine, coming either from the blister rust infected areas of the state or sections adjacent thereto. The wardens are given no authority to make inspections but when contraband material is found they are usually able to arange either for the destruction of the plant material or its shipment to the state entomologist's office for inspection. Posters advising tourists of the regulations are put up in the various public camp grounds."

Apicultural Notes

The sixth annual summer meeting of the Michigan Beekeepers' Association was scheduled to be held at Travers City, Mich., August 6–7.

The annual summer field meeting of the Ohio Beekeepers' Association at the Hartman Farm, near Chillicothe, on August 1, has been announced.

The summer field meeting of the Connecticut Beekeepers Association was held on Saturday, July 5, at the summer home of Mrs. Charles Pettee at Higganum.

Dr. E. F. Phillips will attend the annual summer meeting of the New York State Federation of Beekeepers' Societies to be held in Canajoharie August 1.

Mr. John G. Jessup, instructor in apiculture, Iowa State College, has resigned to accept a position with the A. I. Root Company, Medina, Ohio. He will be located at the branch office, Council Bluffs, Iowa.

The Mid-West Horticultural Exposition to be held at Waterloo, Iowa, next fall, will have a large premium list for the bee and honey exhibits. Application for space

should be made to the superintendent of the Apiary Department, Professor F. B. Paddock, Ames, Iowa.

Dr. E. F. Phillips and Jas. I. Hambleton attended the meeting of the Maryland Beekeepers' Association at College Park, Maryland, on May 31, and will attend the annual summer meeting of Wisconsin beekeepers held by the University of Wisconsin, to be held at Fond du Lac, August 12–14 inclusive.

The Maryland Beekeepers' Association paid its annual visit to the Bee Culture Laboratory of the Bureau of Entomology on the afternoon of July 12, at which time the various members of the staff discussed their respective lines of work. About 60 members of the association were in attendance.

Dr. A. P. Sturtevant of the Bureau of Entomology went to Wyoming and southern Montana in June to study an outbreak of sacbrood. This disease appears to occur more abundantly in this region than in most other parts of the country. Dr. Sturtevant was accompanied on most of the trip by Prof. C. L. Corkins of the University of Wyoming.

All co-operative extension work in apiculture has been discontinued by the Bureau of Entomology. R. B. Willson will continue his work in New York under the administration of Cornell University, and Mr. C. L. Sams who has been doing similar co-operative work in North Carolina, will also be continued without support from the Bureau. The co-operative work in Wisconsin was discontinued July 1.

Dr. E. F. Phillips, who has been in charge of the beekeeping work of the Bureau of Entomology for the past nineteen years, will resign from the Bureau October 1 to become Professor of Apiculture in the Department of Entomology, Cornell University. *Gleanings in Bee Culture* for July gives a summary of the work done in the laboratory under the direction of Dr. Phillips. It is expected that announcement of the appointment of a new Apiculturist will be made in the near future.

The final program of the VII International Apicultural Congress to be held in Quebec September 1–4 has recently appeared. The sessions of the days indicated will be devoted to the discussion of papers on beekeeping subjects. Following this part of the Congress a series of excursions has been planned to continue until September 10, including a week-end excursion to the Saguenay River by boat from Quebec and closing at Montreal. Details of the program may be obtained from M. Cyrille Vaillancourt, local secretary, Ministéré d'Agriculture, Quebec. All papers will be presented in both French and English at separate sessions.

Notes on Medical Entomology

The March issue of the American Journal of Tropical Medicine (Vol. IV, No. 2) contains an article by Geo. H. Bradley of the Mound, La., laboratory of the Bureau of Entomology, entitled "The Natural Breeding Places of Anopheles Mosquitoes in the Vicinity of Mound, Louisiana."

On May 5, Mr. R. C. Shannon, at the request of James Ricker and with the permission of the Bureau of Entomology, went to Poland Springs, Me., where he spent ten days investigating the mosquito situation of the Poland Springs estate. The North Woods Aëdes species were found to be very abundant in the temporary pools and small ponds about the place. Control measures were immediately started. Investigations of other insects were made at the same time. On his way back, Mr. Shannon stopped off to see the collections of Diptera at Cambridge and Boston.

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Proceedings of the Ninth Annual Meeting of the Pacific Slope Branch of the American Association of Economic Entomologists

The ninth annual meeting of the Pacific Slope Branch of the American Association of Economic Entomologists was held at Stanford University, June 27–28, 1924.

The opening and closing sessions were devoted to short business meetings, while the intervening time was occupied with the reading of papers and discussion. Following the Friday afternoon session the Federal and State entomologists opposed each other in the first annual championship Pacific Slope ball game. Due to a violent collision between one of the catchers and the official scorer, whose equilibrum and decorum were entirely upset, the official score was lost, but it is believed that the State Entomologists were victors. After the ball game a barbecue was substituted for the usual banquet and proved to be a very pleasant innovation.

PART I. BUSINESS PROCEEDINGS

The meeting was very successful, not only in attendance and number of papers presented, but also because of so many distinguished visiting members. The following members and visitors were present:

B. N. Annand, San Mateo, Cal.
H. M. Armitage, Whittier, Cal.
E. P. Bartlam, Sacramento, Cal.
Lawrence Bruner, Auburn, Cal.
A. F. Burgess, Melrose Highlands, Mass.
H. E. Burke, Palo Alto, Cal.
Roy E. Campbell, Alhambra, Cal.
Thomas R. Chamberlin, Salt Lake City, Ut.
Leroy Childs, Hood River, Oregon.
T. D. A. Cockerell, Boulder, Colorado.
L. R. Cody, San Jose, Cal.
D. L. Currier, San Jose, Cal.
E. R. de Ong, Berkeley, Cal.
R. W. Doane, Stanford University.
Carl D. Duncan, Stanford University.
E. T. Doyle, San Francisco, Cal.
E. O. Essig, Berkeley, Cal.
G. F. Ferris, Palo Alto, Cal.
C. K. Fisher, Alhambra, Cal.
A. J. Flebut, San Francisco, Cal.
Stanley B. Freeborn, Davis, Cal.
L. O. Howard, Washington, D. C.
R. D. Hartman, Cupertino, Cal.
W. C. Jacobsen, Sacramento, Cal.

F. P. Keen, Klamath Falls, Oregon.
A. F. Kirkpatrick, Lindsay, Cal.
J. F. Lamiman, Berkeley, Cal.
A. O. Larson, Alhambra, Cal.
Arthur C. Mason, Lindsay, Cal.
E. A. McGregor, Lindsay, Cal.
C. M. Packard, Sacramento, Cal.
L. P. Rockwood, Forest Grove, Oregon.
Henry H. Severin, Berkeley, Cal.
Harry S. Smith, Riverside, Cal.
Ralph H. Smith, Berkeley, Cal.
S. J. Snow, Salt Lake City, Utah.
L. B. Soliman, Cairo, Egypt.
F. I. Spruyt, Berkeley, Cal.
A. F. Swain, Fresno, Cal.
E. P. Van Duzee, San Francisco, Cal.
Edwin C. Van Dyke, Berkeley, Cal.
Robert K. Vickory, Saratoga, Cal.
Chas. T. Vorhies, Tucson, Arizona.
H. E. Woodworth, Berkeley, Cal.
F. H. Wymore, Berkeley, Cal.
A. E. Yoder, Salinas, Cal.

Report of the Secretary and Treasurer

The membership of the Pacific Slope Branch, being those members of the parent association living in Pacific Slope States or Pacific Islands, is constantly increasing, being now 137. Since our last meeting four members have died, Mr. S. W. Foster, Mr. A. L. Lovett, Mr. R. C. Treherne and Mr. W. B. Turner. These men had all made places for themselves in their profession and their loss is keenly felt.

The financial statement is as follows:

Date	Item	Amount Paid	Balance
Nov. 9, 1923	Received from Mr. Essig		$25.64
Feb. 1, 1924	105 Mimeographed notices	$2.00	
	100 1c envelopes	1.18	
March 24	1924 assessment	5.00	
April 23	115 Mimeographed letters	2.00	
June 7	105 Mimeographed letters	2.00	
Dec. 30, 1923	Interest		.16
June 12, 1924	Conditional deposit from bank		1.00
June 25, 1924	Total received		26.80
	Total expended	14.48	
	Balance on hand		$12.32

Following a report by the membership committee there was a discussion of membership qualifications, led by Mr. Burgess, whose presence and able discussion of this, and other matters during the meeting, did much to bring the Pacific Slope Branch in closer fellowship with the Parent Association.

Chairman Smith appointed the following committees:

Nominating—R. W. Doane, C. M. Packard, C. T. Vorhies.
Resolutions—E. O. Essig, A. O. Larson, T. R. Chamberlin.
Auditing—E. C. Van Dyke, H. M. Armitage.
Membership—Roy E. Campbell.

Final Business, Friday Afternoon 3 o'clock

The final business meeting was called to order by Chairman H. S. Smith, who asked for reports of the following committees:

The Auditing committee reported the account and statement of the treasurer as correct.

The Resolution committee offered the following resolutions:

Resolved: That a vote of thanks be extended to Stanford University for the hospitality in providing the Pacific Slope Branch of the American Association of Economic Entomologists with a meeting place and accommodations for its members and that the secretary forward a copy of this resolution to the president of the University.

Resolved: That a vote of thanks be extended to Prof. R. W. Doane for his untiring efforts in making our meetings both delightful and successful.

Resolved: That a vote of thanks be extended to our Chairman Harry S. Smith for the courtesy, tact and competence with which he has conducted the meetings.

Resolved: That we express an appreciation to Dr. L. O. Howard and A. F. Burgess for their helpful interest and participation in our meetings.

The nominating committee presented the following report:

Chairman—Leroy Childs
Vice Chairman—Stanley B. Freeborn
Secretary—Roy E. Campbell

The reports were all approved as presented and following a brief statement by the new chairman, Mr. Childs, the meeting adjourned.

PART II. PAPERS AND DISCUSSION

Morning Session, Thursday June 27, 1924

Chairman Smith called the meeting to order at 10 A. M. and asked Vice-Chairman C. M. Packard to take the chair.

Vice-Chairman C. M. Packard: We will now listen to an address by the chairman.

SOME PHASES OF PREVENTATIVE ENTOMOLOGY

By H. S. Smith. *Citrus Experiment Station, Riverside Calif.*

(Paper not received for publication)

At the close of the address Chairman Smith again took the chair and called for the following papers.

SOME HABITS OF THE CALIFORNIA LEAD CABLE BORER

By H. E. Burke

(Paper not received for publication)

THE GARDEN CENTIPEDE, *SCUTIGERELLA IMMACULATA* (NEWPORT), A PEST OF ECONOMIC IMPORTANCE IN THE WEST

By F. H. Wymore,

Division of Entomology and Parasitology, University of California

Abstract

The garden centipede, *Scutigerella immaculata* (Newport), is found widely distributed throughout the world and has been studied by zoologists for many years in relation to the supposedly ancestral characters of insects, chilopods and diplopods. In recent years it has been considered by economic entomologists of California, Oregon and Utah as among the most important and destructive pests in many truck crop sections of these States. In California it is particularly destructive to asparagus shoots and seedlings of beans, peas, melons, etc., the injury being due to the pest's eating numerous small holes in the host. All stages in the life history of the little animals have been found in the intensively cultivated asparagus fields.

Paradichlorobenzene and calcium cyanide as soil fumigants have given encouraging results in controlling the symphylid and other soil pests and more extensive experiments with these chemicals are in progress. In the asparagus fields of the Delta region of the Sacramento River, flooding has proven quite practical as a control in several cases. Best results from flooding have been obtained where the fields were kept thoroughly and continuously covered to a depth of a foot or more for from two to three weeks.

The *Symphyla*, an order of *Myriapoda* to which the garden centipede, *Scutigerella immaculata* (Newport), belongs, are of unusual scientific interest. Because of their supposed primitive characteristics the animals have held the attention of many Zoologists since 1763, the year in which Scopoli described the first species of this order, viz. *Scutigerella nivea*, which he referred to the genus *Scolopendra*. In all the papers reviewed by the writer or referred to by other writers, published between 1763 and 1905, it was not even suggested by the authors that those very small symphylids might some day become an economic pest. The main reasons were, perhaps, that it was commonly supposed that the little animals were to be found only in very secluded regions and that their food consisted of microscopic animals.

According to Grassi (1886), they prefer rocky soil in shaded regions for their habitations and where there are no stones the animals are not to be found. Williams (1904) reported that they are to be found isolated beneath flat stones in the drier portions of a stream bed and in restricted areas along the body of the stream.

Williams (1907) makes the following statement concerning the habits of *Scutigerella immaculata*: "The chief factors determining their distribution seem to be an atmosphere of great humidity, a moderate tem-

perature, comparative darkness, and an undisturbed—at least uncultivated—soil."

He also suspected that the garden centipedes fed partially upon vegetable matter and conducted certain feeding experiments. One of these showed that in captivity the animals survived much better when kept in an environment of damp, decayed leaves. In his summary and conclusions, however, he states, "*Scutigerella* is probably carnivorous."

In certain localities in California, Oregon and Utah evidence of their feeding habits and their habitat in cultivated fields is plain enough. *Scutigerella immaculata* (Newport) has proven to be a real pest to asparagus in California on the various islands in the Delta section of the Sacramento River. Asparagus growers report that twenty years ago several fields of asparagus on Grand Island had to be plowed out because of these animals which were wrongly supposed to be wireworms. The first published account of the garden centipede work appeared in Bulletin 165, California Agricultural Experiment Station, April, 1905. This bulletin includes an illustration showing the nature of the damage done to asparagus shoots and a description of the pest under the name wireworms.

The first record we have of economic injury directly attributed to this pest is a paper by Woodworth (1905). In this paper he describes the centipede as a new species, *Scolopendrella californica*.[1] Quoting from the above paper, "It was first noticed, as far as can be learned, some three or four years ago in the large asparagus fields on Boldin Island and about Sacramento, and proved to be a pest of a very serious kind."

In the winter of 1912–1913 the asparagus farmers of the Delta section of the Sacramento River urgently appealed to the University of California for assistance in controlling the garden centipede. Much work was done at this time by E. R. deOng in testing out repellents and soil fumigants of which carbon disulfid proved effective but was not practical. No further attempt was made to control this centipede until the fall of 1922. At this time another urgent appeal for assistance in controlling this pest was made to the Division of Entomology and Parasitology by the asparagus farmers of the Delta country, representing approximately forty thousand acres of asparagus. To the writer was assigned the

[1]In a letter from Dr. R. V. Chamberlin, Museum of Comparative Zoology, Cambridge, Mass., concerning specimens of the symphylids sent to him from California, he states, "These specimens are *Scutigerella immaculata* (Newport). I find no variations that I regard as significant in comparison with typical representatives from Europe."

problem of studying this pest in the field and developing a practical method of control if possible.

Observations and experiments have been continued throughout the past two years, most of the work being done on the large asparagus ranch of the California Packing Corporation on Ryer Island in the Delta region of the Sacramento River.

Distribution. According to Hansen (1903) members of the order *Symphyla* have been found in Europe, Algeria, Cape Colony, Venezuela, Chile, Southern Brazil, Patagonia, Java, Sumatra, Siam, India, Mexico and Northeastern United States.

Previous to 1903 there had been but four accepted species of the *Symphyla* described in the 138 years that had elapsed since Scopoli in 1763 described the first species known as *Scutigerella nivea*. These four species had been found only in Europe and in the United States. To quote from Hansen, "I venture to state that species of this group can be captured in all countries of the world with the exception of the Arctic and Antarctic regions."

After studying twenty-four species, Hansen is of the opinion that *Scutigerella* is distributed a little nearer to the polar regions than *Scolopendrella*. He also believes that more species of *Scolopendrella* than of *Scutigerella* will be found in warmer regions. He states that with the exception of *Scutigerella immaculata* the distribution of all the known species must be regarded as moderately limited. This species in 1903 was known to be distributed from 60° latitude North, throughout Europe, including Sweden, Denmark, England, France, Germany, Austria and Italy. In Africa it was known in Algeria; in South America, in Buenos Aires, Argentine; in North America, in Cordova, Mexico; and in the United States, in Massachusetts, Kentucky and Texas. It has since been found in six other states of the United States, including Ohio, Georgia, Colorado, Utah, California and Oregon.

Where it occurs in California, Oregon, Utah the garden centipede has been particularly destructive to truck crops.

In California it has been quite destructive in certain parts of Yuba, Humboldt, Sonoma, Yolo, Sacramento, San Joaquin, Ventura, Santa Cruz, Santa Barbara and San Bernardino counties; in Oregon, in Lane, Umatilla, Yamhill, Clackamas, Jackson, Linn, Multnomah, Marion and Benton counties; in Utah, in Davis and Juab counties.

Description. The garden centipede, *Scutigerella immaculata* (Newport), is ordinarily a small white creature but often the body is tinted by the colored food material in the digestive tract, e. g. when feeding on the

tender white asparagus shoots the animals are almost transparent white, while red radishes give a pinkish color; garden beets, a deep red; and decayed vegetable matter and so forth, a brownish color. The adults vary in length from 2.7 to 6.7 mm., are equipped with 14 chitinous plates or scutes on the dorsal body wall, and back of the fourteenth scute is located a pair of cerci in the tips of which are found the openings of the two spinning glands; they have one pair of many-jointed antennae, an eye-like body just back of each antennae, four pairs of mouth appendages; twelve pairs of well developed legs, the first pair four-jointed, all the rest five-jointed. At the base of each leg (excepting the first two pairs) near the coxal sac is found a small appendage (parapod) which is considered by some authors as a rudimentary leg.

The genital opening is located on the ventral side between the fourth pair of legs. The last body segment bears a pair of sensory organs out of which projects a long seta or sensory hair several millimeters in length.

HABITAT. As was mentioned above, *Scutigerella immaculata* until 1905 was supposed to occur only in isolated regions under leaves, rocks, logs, etc. During the last two years the writer has been able to find the adults in the soil about the asparagus crowns or in an intensively cultivated garden in the Delta region any season of the year. During the months of May, June and July, however, the young greatly outnumber the adults.

As the surface soil dries out in the late summer after the cutting season (after July first), the little animals migrate downwards always keeping in the moist earth.

EGGS. The eggs of *Scutigerella immaculata* are laid in clusters of from four to twenty, in the runways of the little creatures. The eggs have been found in the asparagus fields as early as March second and as late as August seventh. They are most numerous during May and June.

When first laid the eggs are a pearly white and as the time for hatching approaches they become a dirty white color. They are 2/5 to ½ mm., in diameter and are covered with tiny ridges giving the appearance of a network.

LARVAE. When first hatched the larvae are hairy little creatures varying from .9 to 1.1 mm., in length, have six pairs of legs, six-jointed antennae and nine scutes. As in the adult, the first pair of legs has four joints, while all others are five jointed.

Williams (1907) in his observations of *Scutigerella* in Ohio found the newly hatched larvae to possess seven pairs of legs. There is a possible error in his work in that his observations were made about four days

after the larvae had hatched, and according to the writer's observations, the young molt for the first time three or four days after hatching.

In many respects the larvae with six pairs of legs are different from more mature forms: they are not so lively, their movement being more like that of the members of the family *Poduridae* than the adult *Scutigerella;* the scutes instead of being notched, are rounded posteriorly and possess numerous long setae; the cerci turn down and the spinning apparatus apparently does not function, and the second antennal joint is cylindrical in shape and twice as long as the normal urn-shaped joints. After the first molt, however, the little animals with seven pairs of legs become fully as active as the adults, and the scutes, although no more in number than before molting, take on the normal shape of those of the adult; the cerci function normally and the antennae become thirteen jointed, and in appearance and function are like those of the adult only they are shorter.

Growth takes place by the intercalation of a pair of legs and a somite just in front of the last somite, that which always bears the sense organs.

Food Plants. The tender shoots of asparagus, the germinating seeds of lima and common beans, vetch, peas, muskmelons, cucumbers and the succulent roots of sugar beets, garden beets and radishes have, in certain localities of California, been the principal hosts of this garden centipede. They also have been found attacking the fleshy roots of corn, morning glory, wild mustard, rhubarb, alfalfa, wild lettuce, needle grass and foxtail, but only to a limited degree.

In Oregon and Utah, however, it has in certain localities kept all vegetation from growing. In a letter dated August 31, 1923, I. M. Hawley of the Agricultural Experiment Station, Logan, Utah, concerning the garden centipede states as follows: "I consider it our worst pest in the State as it is in our main truck section in Davis County where land is very expensive. It is not uncommon to plant most any kind of seed two to five times and have them take it every time. I have seen an asparagus bed where it killed it completely and even weeds could not get a start." A. L. Lovett of Oregon Agriculture College, Corvallis, Oregon, in a letter dated November 23, 1923, makes a similar statement of its work in Oregon, as follows: "It seems to be rather erratic, occurring in such numbers in limited areas as to destroy all sprouting seeds, even keeping patches cleared of weeds."

While the little animals seem to thrive on an abundance of succulent plant food, the writer has found them to exist very well for several months where no succulent material was present, and has been able to

keep live specimens in a small tin box containing moist earth for as long as nine or ten months.

NATURE OF INJURY. The garden centipedes feed beneath the surface of the soil eating numerous small holes in the host.

FLOODING. Among other suggested methods for control of the garden centipede, E. O. Essig in Circular No. 204, University of California Agricultural Experiment Station, suggests flooding as a possible means of control of this pest. After many attempts with the use of insect repellents for the control of the centipedes had failed, Ed. Shelley, a farmer on Grand Island, in 1921 made an attempt at flooding. Although the small temporary levees used in this experiment did not hold the water on the field long enough to drown all the symphylids, Shelley found that the infestation was greatly reduced the following season. The experiment was repeated the next winter, 1922–1923, and this time he succeeded in thoroughly flooding small areas on his farm for three weeks. The writer kept a fairly thorough check on this field during the growing season of 1923 and could not find any trace of the symphylids on the well flooded plots and found that the numbers were greatly reduced on areas where the land had been partially covered.

After discussing the results of this experiment with officials of the California Packing Corporation Land Department, it was decided to prepare for flooding 500 acres of the infested area on their large asparagus ranch on Ryer Island. It was necessary to construct over five miles of levee to hold the water on this acreage. To furnish the water, three 12-inch pumps were kept running day and night pumping water from the river into irrigating canals on the ranch. Due to a mistake in checking-up on the level of the field, only about 450 acres were thoroughly flooded. Where the ground was covered only about six inches deep not quite 100 per cent control was secured, but where it was covered to a depth of a foot or more, no centipedes have reappeared to date, which at present would seem to mean extermination.

SOIL FUMIGANTS. Various experiments were conducted with soil fumigants during the past two years for the control of the garden centipede in the asparagus fields on Ryer Island. Paradichlorobenzene and orthodichlorobenzene and calcium cyanide were tested under a number of different conditions. Paradichlorobenzene proved very efficient in killing the little animals when one ounce of material to three linear feet was scattered along on both sides of the asparagus row, a garden hoe being used to make the furrows close to the crowns. This experiment was conducted during the latter part of May when there was yet considerable

moisture in the soil, and at a soil temperature of 56°F. Later experiments with part of the material applied with a beet seeder and part plowed in with a garden plow when the soil had become drier, were not nearly so efficient. Further experiments with paradichlorobenzene and calcium cyanide are now in progress, the material being applied soon after leveling the ridges.

REPELLENTS. Upon the suggestion that insect repellents might be effective for the pest in the asparagus fields, many materials such as various forms of lime, tobacco dust and others were tested, but without any apparent repelling effect. These materials were scattered along on top of the asparagus crowns and covered with a heavy ridge of dirt. Some work has also been done and other experiments are being planned with the use of repellents for the protection of sprouting seeds, bulbs and so forth, in the small gardens and truck crop fields.

A discussion followed, lead by Mr. E. O. Essig, who emphasized the importance of the entomologist having a better understanding and knowledge of the best farm practices.

CYLINDROCOPTURUS JATROPHAE FALL, A NEW ECONOMIC INSECT

By CHAS. T. VORHIES, *University of Arizona, Tucson, Arizona*

ABSTRACT

Serious damage to chrysanthemums in one garden in Tucson, Arizona, by a small stem borer proved to be due to a hitherto unrecorded insect pest. This was identified as *Cylindrocopturus jatrophae* Fall, first discovered by Schwarz on *Jatropha* in the Santa Catalina Mountains. *Jatropha* is a native shrub of the family Euphorbiaceae.

Late in July 1923, a citizen of Tucson, Arizona came to me with the complaint that his chrysanthemums were being mysteriously killed, and the statement that he suspected some insect of doing the damage, though he was at a loss to locate anything specifically. An examination of his chrysanthemum bed showed a number of the plants in various stages of wilting and dying. When it was attempted to pull up plants that were badly wilted or quite dead they would usually break off below the surface of the soil. It was found that the stems were being mined by some small borer, and on careful examination boring larvae, a pupa or two, and two adults were found within the tunnels of the stems. So far as could be determined with the small amount of material available it appeared that the eggs were probably laid in pits dug in the bark at the surface of the soil. The larva then mines back and forth upward

and around, but not necessarily completely encircling the stem, and seems to at times go into the stem to or through the center. It appeared later to work downward gradually and by the time it is full grown is making a frass-filled tunnel nearly 1 mm. wide. Pupation as observed occurred in the central pith, but whether always so cannot be stated. The plant is so weakened by even one larva as to break off readily, usually at a point an inch or more below the soil surface, leaving a few roots above the point of breakage. One fresh pupa was observed to transform into the adult in one week. Stems infested with two or more larvae are likely to have a swollen portion above the breakage point with the bark broken and having a diseased appearance. The stem may be so riddled as to be readily broken through at this swelling. From one rather large infested stalk examined with reference to depth of penetration it was found that none had penetrated more than two or two and one-half inches below the soil level.

Specimens sent to Washington for identification were determined by Schwarz to be *Cylindrocopturus jatrophae* Fall., of the sub-family Zygopinae, family Curculionidae; and the further surprising information was secured that it was first found by Dr. Schwarz himself on the south slope of the Santa Catalina Mts., some 15 miles from Tucson, on the stems of *Jatropha macrorhiza*. I say surprising, because *Jatropha* is a Euphorbiaceous shrub, quite unrelated to Chrysanthemum. A recent examination of *Jatropha* plants disclosed that some of the stems of each clump were dead, and these were found to be mined extensively at the crown with frass-filled tunnels closely resembling those found in the damaged Chrysanthemums. No specimens were found at this time. No further infestation in the affected plot has yet been observed this season. This infestation was the only one that came to the writer's attention last summer, though chrysanthemums are quite commonly grown in Tucson. Furthermore, this occurred only one city block, actually about 360 feet, from the writer's chrysanthemums which were unaffected. Whether further infestations occur will be a matter to watch with interest. The nearest probable occurrence of *Jatropha* to the city would be at a distance of about three miles, in the Tucson Mountains.

FACTS CONCERNING PERIODICAL OUTBREAKS OF THE BEET LEAFHOPPER

By H. E. Severin, *University of California, Berkeley, California*

(Paper not received)

The session adjourned at 12:10 P. M.

Afternoon Session, Thursday June 27, 1924

After viewing two interesting and instructive motion pictures on Forest Insect Control and Malaria and the Mosquito, the meeting was called to order by Chairman H. S. Smith, and the following papers presented:

EXPERIMENTS ON THE EFFICIENCY OF LEAD ARSENATE IN PROTECTING APPLES AGAINST CODLING MOTH INJURY

By RALPH H. SMITH, *Berkeley, California*

(Paper not received)

STUDIES OF PARASITES OF THE ALFALFA WEEVIL IN EUROPE

By T. R. CHAMBERLIN, *U. S. Bureau of Entomology, Salt Lake City, Utah*

(Paper not received)

CHAIRMAN H. S. SMITH. We will now call on Mr. Packard to read a paper by W. B. Turner.

MR. C. M. PACKARD. This paper was prepared to record the last work done by Mr. Turner prior to his fatal illness.

THE TULE BILLBUG

By W. B. TURNER,[1] *Scientific Assistant, U. S. Department of Agriculture, Bureau of Entomology*

ABSTRACT

The adult Tule Billbug sometimes injures small grains in California by eating into the stems near the head. The immature stages have been found only in the rootstocks of the tule. There is only one annual generation. The eggs are laid in spring and in early summer, in the mud surrounding the tule roots and sometimes in the tule stems. They hatch in 10 to 13 days. The larvae burrow in the rootstocks during summer and fall, pupating in cells formed at the end of their burrows in fall or early winter. Some change in about 20 days to adults which hibernate in the pupal cells and some hibernate as pupae. Adults emerge in spring and are abroad until late summer. They are strong fliers. Eradication of the tules is the only known means of control.

[1]The writer wishes to acknowledge with thanks the material assistance of Messrs. C. M. Packard and B. G. Thompson in securing the information upon which this paper is based.

Introduction

Extensive injury to corn, sugar cane, small grains and grasses by the group of insects known as billbugs frequently occurs in many parts of the United States, especially to plantings on newly reclaimed swamp lands. In California such damage is much less common, but injury to small grains by a species locally known as the "tule billbug"[2] is occasionally reported, and these instances seem to warrant the publication of such information as has been secured concerning that insect. So far as the writer has been able to learn no detailed observations of this billbug have ever been carried through, even for one season; and for this reason an effort has been made to learn something of its life history in Central California.

Distribution

While the tule billbug has come under the writer's observation only in the Sacramento-San Joaquin delta lands and the lower Sacramento Valley, its distribution probably coincides with that of its native food plant, the large rush known locally as the tule,[3] which is found throughout California. Leng lists (*Sphenophorus*) *Calendra discolor* only from California in his Catalogue of Coleoptera of North America.

Character of Damage to Growing Grain

The injury is the result of the feeding habits of the adult. With the long proboscis the billbug eats into the stem of the plant in the boot, or a few inches below the head in more mature grain. The appearance of the plant attacked is conspicuous and readily recognized, the stem being nearly or completely eaten through, the head becoming whitened or bleached and without kernels or with shrivelled kernels, depending on whether the injury occurs before or after the grain is formed, and the plant rendered worthless except for forage. Barley has suffered the greatest damage by this insect; but injury to wheat and oats has also been observed. So far as known the larvae under field conditions feed only in the rootstocks of the tule and never on the roots of cultivated crops; though A. F. Satterthwait informs us, by letter, that he reared them to adults in the laboratory on timothy corms and sections of corn stalk.

Description and Habits

The egg is white, with a pearly luster, slightly kidney shaped, about one-eighth of an inch in length and one-half that in its shorter diameter.

[2]*Sphenophorus*) *Calendra discolor* Mann.
[3]*Scirpus occidentalis* Chase.

They are deposited separately in the mud in which the tules are growing and occasionally in incisions in the stems of that plant, the great majority being in the former situation. Of 50 eggs secured in the laboratory 35 were laid in the mud at the bottom of the cage. Under more normal conditions the percentage of eggs deposited in the tule stems probably would have been much smaller. Oviposition in the wet soil surrounding the rootstocks undoubtedly is the more common habit. Examination of many of the aerial stems has never revealed any evidence of the larvae feeding therein, and in the dissecting of over 200 pieces of rootstock bearing many times that number of bases of stems only one such base showed the feeding burrow of the descending larva. In this single instance the adult, very small and much distorted, was found dead in the pupal cell in the rootstock.

The newly hatched larva is but slightly larger than the egg, and of the typical burrowing weevil larva shape, pearly white in color, with dark brown head and mandibles. The fullgrown larva is about ¾ of an inch in length and more than half that in diameter, with small brown head, the body white and very much wrinkled. The larvae, on hatching, burrow into the succulent rootstocks, making tortuous tunnels running mostly longitudinally, which steadily increase in diameter. The burrows are filled with masticated fragments of the rootstock. When full grown the larva slightly enlarges the burrow into a smooth walled cell in which pupation takes place. The pupal cells usually are located in the upper portion of the rootstock near the base of an aerial stem, inclined upwards, with the scaly epidermis of the root forming a thin cover over the upper end of the cell.

The newly formed pupa is of a pearly white color, slightly less than the fullgrown larva in size. Just before transforming to the adult the pupa shows a decided pink tint on the thorax, changing to a light brown on the thorax of the newly emerged adult, the wing covers of the latter being creamy white, with reddish lines, the margins being decidedly red.

The adult changes to a very dark reddish brown, nearly black, with light markings on the sides and under surface, from three to five days elapsing before the full coloration appears. The proboscis is about the length of the head and thorax. The adults vary in size from five-eighths to nearly an inch in length, the average being about ¾ of an inch, exclusive of the snout. They are strong fliers, mounting high into the air with a rapid steady flight, and individuals are often found miles from any tule beds. They are sometimes present in large numbers during the

spring and summer among the tules in which the immature stages have developed.

Characteristic cavities are made by the adult in feeding on the tule stems. The incision is elliptical in shape, nearly a quarter of an inch long and half as wide, readily recognized after once having been seen. Underneath this comparatively small opening examination will show that a cavity has been excavated in the coarsely cellular body of the stem, often an inch in length and half as wide. Evidently the adult eats out all the tissue within reach of its proboscis from the original incision. Caged adults were voracious feeders on the green tule stems with which they were provided.

We have some evidence to indicate that the rootstocks of tules which are standing in water all or a considerable part of the time do not become infested.

Life History

The eggs require from 10 to 13 days for hatching. The average period for incubation for 30 eggs under observation during May and early June, 1922, in an unheated room at Sacramento, was 11 days.

Larvae reared in the laboratory attained their full development in about 100 days, during which period they molted four times, including the last cast on entering the pupa stage. An average larval period of 98.4 days is afforded by the records of fifteen larvae reared in the Sacramento laboratory during the summer and fall of 1922.

The pupal period of specimens reared in cages in an unheated room during the fall of 1922 averaged 20 days, varying greatly. Thirty-six pupae in the rearing cages, from which the above average was computed, varied from 10 to 31 days. Five became adult in 18 days, five in 23 days, three in 15, three in 16, three in 17 and three in 22 days, the remainder in from 10 to 31 days. One month is not the maximum pupal period, however, since our observations show that under natural conditions a large proportion of individuals hibernate as pupae.

Seasonal History

There is but one generation a year. The earlier maturing individuals spending the winter months as adults in the pupal cells, and the later maturing ones hibernating as pupae or even larvae. We have no evidence to indicate that adults winter over outside the tule roots, or to show the proportion of hibernating larvae and pupae which mature successfully after hibernation. In the field adults which evidently had

cast off their pupal skins shortly before, were encountered in the pupal cells September 8. In the Laboratory rearing cages adults were first observed on September 20. Emergence from hibernation begins with the first warm days of spring, the beetles having been observed in large numbers on April 6. Attempted copulation was first observed in outdoor cages on March 20, 1922. The first eggs were noted in the Laboratory cages May 1st. In the field newly hatched larvae were taken on June 14. Egg laying continued in the rearing cages until July 5, and eggs were collected in the field August 17. During 1921 larvae were taken in the field on various dates from June 14 up to and including November 23. In 1924 occasional live larvae were still present in tule roots dug from a slough March 10. Pupae are to be found in the field over a long period, having been first observed in the field on September 13, and on many subsequent dates as late as April 25. In the Laboratory pupation was first noted September 12, the latest pupation date was November 7, and all specimens became adult by early December.

Control

So far as known the tule is the only plant in which the immature stages of this billbug normally develop; therefore it is rapidly reduced in numbers where the tule beds are eradicated by drainage and cultivation. Material damage occurs only in the earlier years of such cultivating of reclaimed lands. Being strong fliers the adults are likely to re-establish colonies where the tules are allowed to re-occupy the banks of drainage canals and ditches and thus afford breeding places for the billbug. Under such conditions slight injuries to grain might continue to occur. Eradication of the tules is the only means of control.

Just before adjournment Prof. E. O. Essig made an announcement in regard to the new journal, the Pan-Pacific Entomologist, which was started to fill the need of an organ in which could be gathered together the results of scientific entomological research in the Pacific region. He appealed for hearty support from all.

Friday Morning Session, June 29, 1924

Chairman H. S. Smith called the meeting to order at 9:30 A. M. The following papers were presented.

THE PREPARATION AND USE OF COLLOIDAL SULFUR AS A cCONTROL FOR RED SPIDER

By E. R. deOng, *University of California*

Abstract

Two types of colloidal sulfur have been prepared, (1) by running hydrogen sulfide into a solution of sulfur dioxid; (2) by precipitating lime-sulfur solution with acid. The former (hydrophilic collodial sulfur solution) shows the finest stage of division of sulfur particles. The latter (hydrophobic colloidal sulfur or precipitated sulfur) has a coarser sulfur grain which precipitates in a few days. The sulfur particles in both of the colloid forms are smaller than those of high grade dusting sulfur and hence oxidize more quickly, making them more active in the control of red spider than other forms of sulfur. Comparison of the toxic properties of the collodial solutions with a two per cent lime sulfur solution containing 0.6 per cent sulfur showed that the former were more effective especially at low temperatures. The addition of five pounds of ground or flowers of sulfur will probably prolong the length of time which such solutions would remain effective both as acaricides and fungicides.

While testing the ovicidal action of lime-sulfur solution on the eggs of *Bryobia praetiosa* Koch, a few years ago, it was noticed that although but 50 to 60 per cent of the eggs were ever killed, yet the majority of the mites hatching from the treated eggs died within a few days. This work was done in the early spring when the maximum temperature ranged from 50° to 65°F., temperatures at which ground or sublimed sulfur has little acaricidal effect. This led to the thought that the precipitated sulfur (hydrophobic colloidal sulfur) from the lime sulfur solution was more active than the coarser forms of sulfur. Attempts made at this time to prepare sufficient precipitated sulfur or the hydrophilic form of colloidal sulfur for experimental purposes failed. Developments in the preparation and partial stabilizing of colloidal sulfur solutions have come rapidly in recent years. The great difficulty in handling such solutions is the tendency of the minute particles to aggregate or grow in size especially in the hydrophobic form. This is a serious criticism for the great advantage of such types of solution is the fineness of the particles. The use of a buffer type of colloidal solution such as glue or gelatine retards this tendency, but even then the hydrophobic form has largely precipitated out within a few weeks.[1]

The usual distinction made between a precipitated (hydrophobic) sulfur and a true hydrophilic colloidal solution is largely in the size of the particle. When first formed the colloidal particles show the Brownian movement and the majority of those which are visible under a low power

[1]H. C. Young. The Toxic Property of Sulfur. Crop Protection Digest Bul. 3, June 1923.

microscope range in size from three to six microns (.003 to .006 millimeter) but much of the sulfur in a true hydrophilic colloidal solution is not within the range of visibility at such magnification. Very few particles even of the size noted are visible. After the solution had stood for 21 days, the range in size of particles was from 6 to 30 microns. At this stage precipitation of sulfur is very noticeable. Ground sulfur, 95 per cent of which would pass a 200-mesh sieve, showed a range in size of 8 to 40 microns.

Preparation of Colloidal Solutions

Two methods were followed, (1) hydrophilic colloidal sulfur—made by passing hydrogen sulfid through a saturated solution of sulfur dioxid until the odor of the latter cannot be distinguished. The latter point is important, or if free sulfur dioxid remains in the solution, it is much more apt to burn foliage. Solutions made in this way gave approximately 3 to 7 per cent sulfur by analysis. It will be seen in Table I that this is a very stable preparation in which the particles grow or aggregate but slowly. (2) The second method of preparation (hydrophobic colloidal sulfur) is by precipitating lime sulfur solution by adding concentrated hydrochloric or sulfuric acid. (Phosphoric acid offers some advantages but is more expensive.) The acid was added to the solution to a point of acidity as shown by methyl orange, it usually requiring about 0.5 cc. concentrated acid per 10 cc. of lime sulfur concentrate (1.3° Baume). Such solutions show a tendency to aggregate sulfur particles up to the point of precipitation within a few days. The use of another colloid such as glue or gelatine delayed this especially if the glue solution was added before the acid. For commerical purposes add one pound of glue dissolved in water, to five gallons of lime sulfur solution, then in addition, two to four pints of concentrated acid, or until the yellow color disappears and the solution is slightly acid to methyl orange. A larger amount of glue may be used if the material is supposed to stand several days after preparation and before being used.

Properties of Collidal Solutions

It will be seen from the data in Table I that it is possible to make colloidal solutions either with a sulfur dioxid solution or by precipitating a lime sulfur solution, with acids, that have such finely divided sulfur particles that they are invisible at a magnification of 80 times. Since it is generally accepted that minute particles of sulfur are more effective

TABLE I—PROPERTIES OF COLLOIDAL SULFUR SOLUTIONS

Method of Preparation	Dates of Observation						
	May 16 (first day)	May 17		May 19		May 28	
		Grains	Microns	Grains	Microns	Grains	Microns
Saturated solution of sulfur dioxid plus hydrogen sulfide, 7.3 gm. sulfur per liter	Solution yellow, very few crystals, homogeneous, no visible particles	18	17	4	17	13	8–17
		25	2–7	8	8–17	50	2–7
		25	1–2	9	2–7		
		A few aggregates		A few aggregates		No aggregates	
Unsaturated solution of sulfur dioxid plus hydrogen sulfide, 5.2 gm. sulfur per liter	Homogeneous, no visible particles	1	8	3	8	1	8
		33	1.5–8	50	1–8	50	1–9
		50	1–2	150	1–2	100	1–2
		A few large aggregates			(barely visible)	A few large crystals	
Lime sulfur solution, 5 gm. per liter plus 5 gm. glue Ppt. with hydrochloric acid	White, homogeneous, very fine particles	1	8	9	8	Yellow precipitate	
		5	1–8	30	1–8	1	8
		75	1	6	1	3	2–6
		A few aggregates				25	1
Lime sulfur solution, 5 gm. per liter plus 1 gm. gelatine Ppt. with hydrochloric acid	Heavy precipitate	50	8				
		100	1–8				
		25	1				
		Numerous aggregates					
Sulfur flour 92 per cent passing a 200-mesh screen		6	26				
		14	17–26				
		39	8–17				
		64	7–8				

than large grains both as fungicides and as acaricides then such preparations must be more active than the finest of ground or flowers of sulfur now in use. These fine particles soon aggregate, however, and in a few days may contain many particles similar in size to the better grades of sulfur now on the market. It should be noted, however, that these larger particles formed after a few days do not represent all the sulfur present so that there may still be a large proportion of finely divided sulfur too small to be seen at the magnification at which these measurements were made. Various materials were tried as stabilizers but glue and gelatine gave the best results. The best results being obtained by

adding an amount of dry glue equivalent to two per cent of the weight of the lime sulfur solution used. The glue should always be added in solution and prior to the acid otherwise little good is accomplished.

Experimental Work

Sulfur in the colloidal form particularly the hydrophilic solution, is more dangerous to foliage even than lime sulfur solution. At high temperatures (80°–95° F.) 1 per cent and 0.8 per cent concentrations injured almond foliage, which is quite resistant to sulfur. Peach foliage was slightly yellowed at 0.5 per cent although apricot, plum, apple and orange were uninjured at this concentration over a period of two weeks. The maximum temperature during this time was seldom over 80°F.

Since sulfur has been commonly used at the rate of five pounds of the material to 100 gallons (approximately 0.6 per cent concentration), a comparison at low temperatures of the standard spray of lime sulfur 1 per cent plus five pounds of sulfur and colloidal sulfur solutions 0.6 per cent was made. The results given in Table II show almost perfect control for all three colloidal sulfur solutions while the lime sulfur solution plus free sulfur dropped to 90.6 per cent and the ground sulfur, to 44.9 per cent. These striking results were intensified by the low temperature at which the work was conducted and show the superiority of the colloidal form especially over dry sulfur, under conditions where sulfur in the coarser form is not very active. Experiments at higher temperatures showed less difference but even then the colloidal forms were always superior. Good control was also obtained in laboratory experiments at concentrations as low as 0.06 per cent, one-tenth that at which the data are given. The weaker concentrations offer the possibility of treatment for plants that are quite susceptible to sulfur injury. Little difference will be noted in the acaricidal value of hydrophilic and hydrophobic solutions when extended over a period of nine days; although for shorter periods the difference ranged from eleven to thirteen per cent.

Under California conditions where most of our control work on red spider is done at high summer temperatures, it is doubtful if colloidal sulfur solutions could be economically substituted for lime sulfur solution containing free sulfur, at least until an inexpensive process of manufacture is established. Finely divided precipitated sulfur either as a paste or in the dry form may be a more satisfactory form than true colloidal solutions. The latter, however, may find a place for use in the early spring or in regions where low temperatures retard the oxidation

TABLE II—COMPARATIVE TOXICITY OF COLLOIDAL AND GROUND SULFUR AND LIME SULFUR SOLUTION ON *Bryobia praetiosa* KOCH[2]

Material Used	Date Prepared	Per cent Sulfur	Observed 6/11				Observed 6/14				Observed 6/18			
			Adults Dead	Adults Alive	Larvae Alive	Per cent Dead	Adults Dead	Adults Alive	Larvae Alive	Per cent Dead	Adults Dead	Adults Alive	Larvae Alive	Per cent Dead
Colloidal Sulfur Solution (Sulfur dioxid and Hydrogen Sulfide)	6/9	0.6	83	19	5	77.6	213	15	3	92.3	228	...	...	100
Colloidal Sulfur Solution (Sulfur dioxid and Hydrogen Sulfide)	5/16	0.6	..	..	..	....	391	22	12	92.0	413	...	4	99.1
Fresh Precipitated Colloidal Sulfur (Lime Sulfur Solution and Sulfuric Acid)	6/9	0.6	139	70	7	64.4	463	93	11	81.6	555	1	7	98.9
Lime Sulfur Solution 2% plus 5 pounds Ground Sulfur per 100 gallons	6/9	0.6	129	97	21	52.2	267	90	50	65.6	350	7	28	90.6
Ground Sulfur (Applied as Dust)	...	...	22	65	0	25.3	70	212	56	20.7	182	110	114	44.9
Check			11	41	25	14.3	13	23	103	10.3	21	14	94	16.3

[2]Applications made June 9. Maximum temperature 6/9 71°, 6/11 71°, 6/12 78°, 6/13 72°, 6/14 76°, 6/17 72°, 6/18 74° F.

of sulfur. They also offer a very promising field as a fungicide especially for the resistant forms of fungi such as rose and grape mildew. The duration of the activity of colloidal sulfur solutions was not carefully tested. Should it be that the very fine particles such as are found in hydrophilic colloidal solutions oxidize so rapidly as to be of a temporary nature, then it is possible that the addition of finely ground sulfur to the spray might prolong its effectiveness.

THE EFFECT OF WEEVILY SEED BEANS UPON THE BEAN CROP AND UPON THE DISSEMINATION OF WEEVILS, *BRUCHUS OBTECTUS* SAY AND *B. QUADRIMACULATUS* FAB.

By A. O. Larson, *Associate Entomologist, U. S. Bureau of Entomology*

Abstract

The experimental work herein reported has been carried on for several years with the object of determining the influence of the weevily beans and cowpeas on the production of the crop as well as the probability of the infestation of the crop by weevils, *Bruchus obtectus* Say or *B. quadrimaculatus* Fab., which were contained within the planted seeds. While the planting of weevily beans reduces the yield it does not appear to have any bearing on the infestation of the succeeding crop.

That the planting of weevily beans may have an injurious effect on the succeeding crop has been emphasized very strongly by many who have written on the control of weevils. Usually the exact nature of the injury is not given.

Bremner[1] in 1910 gives the inference that the dissemination of weevils to infest the growing crop is the main, if not the only injury resulting from the planting of weevily seeds (1).

Back and Ducket[2] in 1918 said, "If seeds are planted that contain weevils, the adult weevils emerge from the seed after it has been planted and live in the field until the pods are sufficiently developed to receive the weevil eggs. They add their numbers to those in the field that have migrated from the place of seed storage. To plant peas, beans and cowpeas containing living weevils only invites a 'buggy crop'." In 1922 Back[3] said "the germination of beans, peas and cowpeas is likely to be seriously affected by the development of weevil larvae. If the embryo is destroyed by the larva, or if too much of the bean substance is eaten, the seeds can not grow."

Popenoe experimented in Kansas[4] with weevily beans as well as peas with the following results. "Fifty percent started: of these, three-fifths might have grown into plants, as the injury was restricted to the

[1]Figures not in parenthesis refer to literature cited.

seed leaves. But the remaining two-fifths were variously mutilated by the loss of a part or the whole of the germ or plumule, so that under no circumstances could they have made plants. Here then, but 30 percent could have passed the germinating stage, and these, owing to more or less considerable injury to the seed leaves, would probably have made plants of low vigor. In a check lot of perfect beans of the same varieties and in the same numbers, planted alongside, 95 percent germinated."

Razzanti[6] in Italy concluded from experiments carried out in 1917 that weevil infested beans were unsuitable for seed. He found that the percentage of unattacked beans which germinated was 84 and that of infested beans was on an average only 23.6. Plants from infested seed were weak and subject to fungus diseases and gave a smaller yield of inferior quality.

Similar, if less extensive, experiments with various kinds of peas and beans have been recorded by Riley and Howard,[5] Lintner,[10] Goff,[11] Beal,[12] and Wood.[13]

The present paper gives the results of investigation carried on by the writer (2) for several years in Alhambra, California and corroborates some of the foregoing statements and indicates that the others do not apply to the above named weevils.

Weevily Beans Defined

The term "weevily beans" is general, and may be applied to any one or all of the following classes of beans; (1) Beans containing living weevils of any or all stages, but from which no weevils have emerged; (2) Beans having no emergence holes, but containing dead weevils of one or more stages; (3) Beans from which some weevils have emerged, and in which there remain weevils, dead or alive; (4) Beans from which all weevils have emerged, and (5) Clean beans among which are a few beans of either of the foregoing classes. In this paper only those of the first 4 classes will be considered.

Germination in the Laboratory and in the Feild

During 1921 germination tests of weevily beans were made in the laboratory, and they showed that beans having as many as 9 emergence holes would germinate. The heavier the infestation the greater was the

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[2]The writer received valuable assistance from Edgar Nelson, Albert H. Amis and C. K. Fisher in counting weevil holes, making germination tests and planting and caring for the growing crop, as well as in making observations of weevil injury to the growing plants.

chance that the plumule or germ would be injured, but as long as the plumule was not injured the number of emergence holes had little effect upon the power to germinate, under favorable laboratory conditions. Under less favorable conditions the weevily beans would rapidly become soft and putrid. Under similar conditions putrefaction always became apparent first in the beans containing the greatest number of emergence holes. Blackeyed cowpeas became putrid more quickly than any other variety of cowpeas or beans tried.

When planted in the field, as soon as decay began, the beans were attacked by a mite sp? which accelerated decomposition. Cold wet weather retarded the germination of the beans and seemed to furnish ideal conditions for the development of this mite, as well as for the development of the root maggot, *Egle cinerella* Fall., and other insects which aided in destroying the beans before they were out of the ground. Because of unfavorable weather conditions in 1921 many Southern California farmers were forced to replant Blackeyed cowpeas three or four times before a stand was secured. Under such unfavorable conditions beans containing weevil holes are attacked by decay organisms before the other beans, and are destroyed before they germinate or before they show at the surface of the ground. Under more favorable conditions beans having one or more emergence holes were observed to come up even while the mites were working on them. The cotyledons of such beans had rust brown spots where the mites had been at work. This color was darkest around the weevil holes.

Growth after Germination

For 5 successive years weevily beans have been planted for observation. In 1919 the writer planted Mexican red beans as follows:

100	Mexican	Red	Beans free from weevil injury.			
100	"	"	"	each having 4 or 5 weevil holes.		
6	"	"	"	"	"	11 or 12 weevil holes.
50	"	"	"	"	"	1 weevil hole.
50	"	"	"	"	"	2 " "
50	"	"	"	"	"	3 " "

They were planted under favorable conditions in the middle of the garden. There was a noticeable difference in the size and thrift of plants which grew from the clean beans and from those having one hole each, the former being a little more vigorous. Likewise when comparing the plants from beans having one and two holes respectively there was a distinct difference in favor of the former. The same was true when comparing the plants from beans having two holes and those having three holes.

The difference in the size of the plants was most marked about the time the blossoms began to appear. There was not a perfect stand of the latter, and some died before producing beans. None of the beans having 11 or 12 holes came up, and only a few of those having 4 or 5 holes came up. These were small weaklings, having a struggle to exist and finally succumbed to the attack of red spider without producing beans.

In 1922 plantings of weevily beans were made as indicated in Table 2. Where possible, lots of 100 beans, free from weevil infestation, containing living weevils, dead weevils, and emergence holes from 1 to 10 or more were planted. With some varieties of beans, when it was impossible to get the desired number, a smaller number was used. There were no emergence holes in the beans containing either living or dead weevils. In some instances it was later found that all beans in these two groups did not contain weevils, as they were thought to. The tiny larvae had died immediately after making their minute entrance holes through the seed coats. It was impossible to tell before planting how many dead weevils were inside of the beans in any infested lot containing either dead weevils or emergence holes. Likewise it was impossible to determine before planting how many living weevils were within each seed in the lots containing living weevils; but by dissecting beans from each lot which was taken it was possible to determine the approximate size of the weevils in each lot.

All lots were planted the same way and at approximately the same depth in the open spaces in an orange orchard. The moisture condition was quite nearly uniform for all that were planted on the same date. The climatic conditions during the period immediately following the planting may not have been all that could have been desired, as the sky was cloudy almost constantly, with the exception of three hot days as is shown in Table 1. The humidity was high, but the temperature appears to have been high enough to insure a rapid development of young bean plants.

Table 2 shows a great difference in the number of plants that came up from different varieties, as well as from different lots of beans. It also shows that a greater percentage of the clean beans or those being free from weevil attack, came up and grew, than of the others. More plants came from beans containing living weevils than from beans containing dead weevils. This may be partly accounted for by the fact that a few more beans were later found to be free from weevils in this group than in the other. A few young bean plants were killed by cutworms and other

TABLE 1. SHOWING TEMPERATURE AND HUMIDITY DURING THE PERIOD FOLLOWING THE VARIOUS PLANTINGS, MAY 5–22, 1922

	Temperature			Humidity		
May	Max.	Mean	Min.	Max.	Mean	Min.
5	80	69	58	74	64	55
6	66	62	59	76	69	63
7	63	60	57	80	76	72
8	71	63	55	79	67	55
9	64	56	48	81	67	53
10	73	58	44	72	60	48
11	82	65	49	72	54	36
12	93	74	55	61	44	28
13	104	80	62	52	38	24
14	90	77	64	55	48	42
15	84	74	65	74	64	55
16	82	72	62	76	66	56
17	76	68	60	78	69	60
18	71	63	57	75	69	64
19	80	68	56	75	63	51
20	78	68	59	70	62	55
21	84	69	55	76	62	49
22	89	73	57	74	57	41

insects and are not included in Table 2. Eighteen, seventy-five and one-hundred per cent of the plants coming from beans having 3, 4 and 5 holes respectively, died early in the summer.

PHYSICAL INJURY TO YOUNG PLANTS

After the bean plants were up the weevil holes showing in the cotyledons were surrounded by a hard brown area. Usually the pupal cells and weevil emergence holes extended through one cotyledon and well into the other. This had a tendency to keep the cotyledons from separating properly after the bean had forced its way up out of the ground. Frequently the testa or seed coat was held firmly attached to the cotyledons by the hard brown area surrounding the emergence holes. This kept the cotyledons from spreading, thus crowding and dwarfing the primary leaves; in some instances the cotyledons would break off leaving only the hypoctyl and the early stage of the primary leaves. The food supply in the cotyledons which should have nourished the young plant while it was becoming established, was thus removed, and the plant was starved to death.

The greater the number of emergence holes there were present in the beans, the greater was the probability that decay and mites would kill

TABLE 2. PERCENTAGE OF MATURE PLANTS PRODUCED BY CLEAN BEANS AND COWPEAS AS WELL AS BY WEEVILY SEEDS*

Variety	Seeds free from infestation	Seeds infested with		Seeds containing no weevils but containing the following number of emergence holes in each seed									
		living weevils	dead weevils	1 hole	2 holes	3 holes	4 holes	5 holes	6 holes	7 holes	8 holes	9 holes	10 holes
California Pink	89	90	—	76	12	5	1	0	0	0	0	0	0
Italy's Favorite	94	—	—	—	—	18	0	0	—	—	—	—	—
Colorado Pinto	80	4	3	1	0	0	0	0	0	0	0	0	0
Red Kidney	87	—	0	33	7	0	0	0	0	0	0	0	0
Brown Kentucky Wonder	48	5	4	0	0	0	0	0	0	0	0	0	0
Cranberrys	77	6	5	0	0	0	0	0	0	0	0	0	0
Canadian Wonder	—	0	0	0	0	0	0	0	0	0	0	0	0
Superior Kentucky Wonder	—	84	79	7	0	0	0	0	0	—	—	—	—
Spotted Red Mexican	75	—	—	—	—	—	—	—	—	—	—	—	—
Refugee Green Pod	—	—	0	0	0	0	0	0	0	—	—	—	—
Lady Washington	—	—	49	6	0	0	0	0	0	0	0	0	0
Yard Long	52	—	—	5	0	0	0	0	0	—	—	—	—
Blackeyed Cowpeas	—	85	0	0	0	0	0	0	0	0	0	0	0
Holstein Cowpeas	—	—	18	91	35	2	0	0	—	—	—	—	—
Red Ripper Cowpeas	74	70	—	—	—	—	—	—	—	—	—	—	—

*Dashes (—) indicate that no seeds were planted. Zero (0) indicates that seeds were planted but failed to come up.

the plumule before the plant was up, and also the greater was the chance that the cotyledons would not be capable of separating properly after the plants were up. It was evident that decay was directly proportional to the number of emergence holes in the seed beans. Likewise, it was evident that decomposition was more rapid in beans containing dead weevils than in those containing living weevils. This may be due to the fact that the dead weevils, in all but the adult stage, decompose quite rapidly when moistened as they would be inside of a bean in damp soil. While the seed coat retarded decay the dead bodies within the bean hastened putrifaction.

Young Plants Starved

As a result of carefully weighing hundreds of Red Ripper cowpeas, the writer finds the loss in weight of the dried cowpeas is 18 to 22 per cent for 1 hole; 28 to 33 per cent for 2 holes; 33 to 38 percent for 3 holes; and 38 to 45 per cent for 4 holes, depending upon the size of the cowpeas infested and the weevils emerging. With larger cowpeas and beans the loss in weight caused by each weevil would not be so great. The greater the number of weevils there are in a bean of a given size, the smaller will be the emerging weevils, and consequently the smaller will be the percentage of weight loss per weevil.

On a normal young bean plant the cotyledons shrink in size and wrinkle up, become leathery in texture and are practically all absorbed by the growing plant. The cotyledons of a weevily bean do not shrivel and wrinkle as rapidly and the texture does not become so leathery. The transformation of the plant food is slower and the growth of the plant is correspondingly slower. The supply of stored plant food is smaller, not only by the amount actually eaten by the weevils, but also by the amount that is made unavailable around each cavity made by the weevil.

After years of experimenting with large and small beans of the same variety, Mr. A. W. LaForge of the California Bean Growers' Association makes the statement that the small beans of a given variety have a tendency to produce smaller vines and fewer pods than are produced by the larger beans. He says they also produced a greater percentage of "buckskins," or pods in which no beans mature and have a tendency to produce inferior beans. He attributes this to a more limited food supply while the plant is becoming established. The writer's observations on plants coming from weevily seed beans as compared with vines from clean beans of equal size seems to point to a similar conclusion that the

amount of stored plant food available for the young plant is a very important factor in the production of the coming crop.

Observations on the Weevils Contained in the Cotyledons After the Plants Came up

Immediately after the beans came up it was not always possible to see the weevils which were contained in the cotyledons; however, the larger weevils were visible so that daily observations could be made without disturbing them. The dead weevils were observed only to see their effect on the rate at which the cotyledons were absorbed by the young plants. Living weevils were observed to see what if any was the likelihood of their infesting the growing crop.

There were living larvae, pupae and adult weevils in lots of Pinto, Brown Kentucky Wonder, Superior Kentucky Wonder, Canadian Wonder beans, and in Blackeyed cowpeas when they were planted. There were living pupae and larvae in Red Ripper cowpeas and living larvae in Pink and Cranberry beans. None of the Canadian Wonder came up.

After the beans came up no living adults were found, although dead adults were found where it was expected that live ones existed. Living pupae were observed on different dates, but were not observed to be alive on more than two successive days. Generally the dead pupa was found in the cell, but in two instances the pupae were gone. They were undeveloped, so they could not fly. If wind or other agent had shaken them out of their open pupal cells they would have fallen into dust and dirt, where they would have perished.

On May 16th, nineteen living larvae were observed, only six of which were alive the next day, and only one survived until May 22nd, and none until May 23rd. Larvae that were not in sight on May 16th became visible later, and the more completely the larvae were covered in the cotyledon the longer they lived. This was forcefully illustrated when on May 20th a cutworm cut off a bean plant in which only one larva had been found on the 16th, the same larva being dead on the 17th. On dissecting the cotyledons of this plant two living larvae were found. One larva was found to live 9 days. The larvae shriveled up and appeared to die from starvation, whereas, the pupae and adults appeared to be killed by the excess moisture in which they found themselves when the bean had changed from its former dry condition to that of a moist growing plant.

This indicates that no weevils planted in beans will live to escape into

the field, as the cotyledons are dried up and gone before larvae could mature, and the older stages of weevils do not appear to be able to survive the change through which the bean goes. Adults may emerge from the planted bean before it has undergone much change, but the writer's observations on the length of life of the adult weevil indicate that the weevil does not live more than 2 months in the summer. These observations on the length of life of the adult weevils are born out by those of Slingerland[7] and others.

If weevils which were planted in the seed beans were able to survive the above-named hazards and get into the field alive, they would have to live more than two months before the crop would be in a condition in which it could be infested.

Oviposition in the Field

In the field the common bean weevil, *Bruchus obtectus* Say, lays its eggs in the pod after the beans are well matured, and preferably after they are ripe. It has never been observed to lay eggs on the leaves, vines or blossoms. The four-spotted cowpea weevil, *B. quadrimaculatus* Fab., lays its eggs on the pod or on the seeds after the pod has split open. With both of these weevils the great majority of the eggs are laid during the early part of their life, and the eggs laid late in the life of the female usually do not hatch.[8]

Does the Planting of Weevily Beans Invite a "Buggy Crop?"

In order to determine if possible whether or not weevils coming from late planted beans could infest crops having been planted earlier, plantings of beans other than those enumerated in Table 2 were made as follows:

April 11th, 2 rows of Black spotted cowpeas, two rows of Blackeyed cowpeas, one row each of Mexican Red, Pinto and Dutch Caseknife. Of these only the last-named variety was free from weevils. The others were badly infested with living weevils, some with *B. obtectus* and others with *B. quadrimaculatus*.

On April 12th were planted one row each of the following: Lazy Wife, Burpee's Stringless Green Pod, Extra Early Refugee, Refugee Wax, Early Mohawk, Improved Golden Wax and Brown Kentucky Wonder. Of these none were infested with weevils. The above rows were 120 feet long.

A plot about 8 by 20 feet contained volunteer Lady Washington beans which were up by April 1st. The cotyledons of these had not been

examined to determine the extent of weevil injury the seed had sustained, but they grew from beans that had been piled there, vines and all, the previous autumn for observations as to the effect of the winter weather on weevils in beans left out in the open.

May 25th, one row each of the following varieties of beans and cowpeas were planted: Brown Kentucky Wonder, Cranberry, Bayo, Mexican Red, Pink, New Era cowpeas and weevily Blackeyed cowpeas.

May 26th one row of Superior Kentucky Wonder, Ventura Wonder Wax, Eastern Cornfield, Red Valentine, and a few seeds each of Teparies, Burpee's Stringless Green Pod and unknown varieties culled from seed beans.

One row each of Pink, Mexican Red and Black Wax had been left standing all winter, and were plowed under on April 10th. These beans, remaining in the pods and being kept off the ground, were practically all filled with weevils. Many had emerged before they were plowed under.

It is thought that the different planting of beans, weevily and clean, the volunteer beans, and the beans left standing all winter, furnished a wonderful opportunity for the spread of weevils into the new crop, if it were possible for such a thing to occur in this manner. The beans were carefully watched for the presence of weevil or weevil injury. Beans were ripe by the middle of July, but there had been no weevil work observed, and later observations bore out the fact that no weevil injury had occurred.

On July 22nd, a few *B. obtectus* were liberated, and on July 24th the first weevil work was observed. A few days later some *B. quadrimaculatus* were liberated, and their work was soon noted.

Eggs laid in the laboratory in July were emerging as adult weevils in 27 to 35 days. No weevils were observed emerging in the field in any of these varieties of beans until September. This would tend to bear out the observations that no weevils had been at work in the field before those liberated July 22nd.

Observations by the writer showed that *B. obtectus* lived over the winter of 1920–21 in beans in the field near Wilmington, California, and that they lived over the winter 1921–22 at Alhambra, California. Although that was the coldest and wettest winter experienced there for years, the temperature fell only to 22 degrees F.

Weevils thus going over the winter and coming out in the spring would search for unprotected stored beans with an almost uncanny ability for finding them. Any beans or cowpeas in which they were

able to find a breeding place would serve to liberate another generation of weevils, possibly in June, and these would produce another generation extending through July and August, and these weevils would infest the ripening crop.

The writer is convinced that statements like the following "The adult weevil comes from the seed bean or pea, we plant, so by treating the seed or planting clean seed we need never be bothered."[1] or "—when[9] one uses 'buggy' seed in which the pests are alive, one places the insect in just the best surroundings for their continued welfare;" cannot be applied to *Bruchus obtectus* Say, or *B. quadrimaculatus* Fab.

Conclusions

The planting of weevily beans or cowpeas injures the crop (1) by the injury of the germs causing a large percentage of the seeds to fail to germinate (2) by accelerating decomposition of the seeds while they are germinating (3) by holding the cotyledons together thus preventing the development of the primary leaves and (4) by removing and making unavailable much of the plant food which should aid the young plant in becoming well established thus making weak unproductive plants.

The planting of weevily beans does not appear to have any bearing on the weevil infestation of the new crop.

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THE POSSIBILITY OF WEEVIL DEVELOPMENT IN NEGLECTED SEEDS IN WAREHOUSES

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(Withdrawn for publication elsewhere)

THE CONTROL OF INSECTS IN CEREAL FOOD PRODUCTS

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Abstract

Germea, cream of wheat, corn meal and other breakfast cereals are often found to be infested with insects. In an attempt to find the source of this infestation studies were made of the packages in which these cereals are packed and of the sterilizers at some of the mills, and it was found that frequently the sterilization process is not sufficient to destroy all of the insects.

At other times the cereal is subjected to a reinfestation after it has been sterilized.

A table showing various temperatures at which insects will be killed is given and a description is given of a sterilizing apparatus devised by the author with which electric heat is used to sterilize the cereal with an exposure of approximately two seconds.

At more or less frequent intervals packages of germea, cream of wheat, corn meal, rolled oats and other breakfast cereals are returned by the consumer to the dealer because these packages are found to be infested with insects. Usually the infestation is very light, but the presence of a single insect, especially if it is a larva which is spinning a web wherever it goes, is considered sufficient reason for refusing to use any of the material in the package.

Of course, the question as to the source of this infestation immediately arises. The housewife is sure that the insects did not get in the package while it was in the pantry; the retail dealer feels just as sure that the conditions in his store are not to blame, and so the responsibility is forced back upon the manufacturer who must bear the loss. Whether this is just, must, of course, be determined by a series of observations in the mills and warehouses, but our work during the last eight years has convinced us that where insects are found in well sealed packages the source of the infestation may usually be traced to the mill.

It is a common belief among many millers that some "germ" may get on the grain while it is in the field and, in some mysterious manner, survive the operations that the grain must undergo during the process of preparing it, and finally hatch out or give rise to the insect that is found in the sealed package. This belief is probably due to the fact that in the East and particularly in the South, the Angoumois grain moths lay

their eggs on the grain while it is in the field and the larvae attack the grain either before or after it is harvested, so that infested grain may be brought into the warehouse or mill. These insects attack or breed in the whole grain and are destroyed in the process of milling.

After the grain is ground it may become infested with insects at any time during its further progress through the mill to the packing table. As practically all of the cereals are superheated before they are packed all stages of the insects, if any are present, are usually destroyed by this cooking or sterilization. Sometimes, however the sterilization is not complete and some of the insects may pass on to the packing table and be sealed up in the finished package.

In one mill we found that the corn meal that was coming from the sterilizer had only reached a temperature of 140°F. This is high enough to kill all insect life if this temperature could be maintained for two hours or more, but as the corn meal goes into the sterilizer cold, and as it takes it only four minutes to pass through, it is evident that such sterilization is worse than useless, because it does little or no good and gives a false sense of security. When the steam pressure was raised from 22 lbs. to 30 lbs. the temperature of the corn meal as it came from the sterilizer was raised to 155° to 157° F. At 40 lbs. pressure the temperature of the meal was raised to 174°.

Tests made in our laboratories showed that while most of the insects in germea and corn meal were killed when subjected to a temperature of 180°F. for four minutes, a few beetles and a very few moth larvae survived the ordeal. Our tests show that to be thoroughly effective the temperature must reach 200°F. if the time of exposure in the sterilizer is to be only four minutes. If the temperature is to reach only 180°F. this should be maintained for at least 8 or, better still, 10 minutes.

After sterilization the cereal usually passes through a series of elevators, over various belts and through screens and hoppers. During much of this time it is exposed to contamination by insects. Many of the elevators and hoppers are infested with larvae practically all of the time. Some of these may be carried with the supposedly sterilized cereal to the packing table and be sealed up in the packages. Or some of the moths that are flying about at night may lay a few or many eggs in some of the exposed places and when the mill starts up next morning there is every chance of these eggs being carried directly to the packages where they will be carefully and securely packed with the cereal.

The following brief statement summarizes the results of some of the

tests made in our laboratories with Mediterranean flour moth and various species of bran beetles in all stages of development:

108° to 110° F for 1 hour killed 3-day old Mediterranean moth pupae.
110° F for 4 hours killed about one-half of " " larvae.
120° F " 4 " " all stages of " " but did not kill all of the beetles.
130° F for 4 hours killed everything.
140° F " 3 " " "

170° F	" 10 minutes	—Larvae of moths and beetles, and adult beetles in box with a little germea; all killed.
180° F	" 4 "	Killed most of larvae of Mediterranean moth in shallow pasteboard box ½ full of germea, but some still alive even after 3 days.
180° F	" 4 "	Adult moths and eggs,—in open box all moths killed and no eggs hatched, moths not active after 1½ minutes
180° F	" 4 "	Large and small larvae of Mediterranean moth, adult moths, beetle larvae and adult beetles, all put in a revolving tin cylinder with a small amount of germea and exposed to 180° F. At end of 4 minutes all seemed dead, but after 3 days two of the moth larvae and about ½ of the beetles were still alive.
180° F	" 5 "	Large and small larvae of moths in revolving cylinder with some germae,—many killed but some revived.
200° F	" 4 "	Large and small larvae of moth in revolving cylinder with some germae,—all killed.
196° F	" 5 "	infested box of corn meal in oven; opened 24 hours later and some larvae still alive.
190° F	" 45 "	A badly infested package of corn meal which had been resealed after opening, was put in oven. A thermometer was put in the package so the bulb would be near center of package. At end of 45 minutes the temperature of center of package was 120° F; about 5 minutes later, after being taken from oven it reached 124° F. Package opened on following day and all insects dead.

Thus we see that a direct exposure to a temperature of 180°F. for 4 minutes is fatal to all stages of the Mediterranean flour moth, but as soon as the insects are protected by even a very small amount of cereal the temperature or the time of exposure must be increased in order to kill all of the insects. The bran beetles are a little more resistant than the Mediterranean flour moth to the effects of high temperature.

In another set of experiments in which we used eggs, larvae and adults of a bran beetle (*Echocerus cornutus*) we found that a direct exposure of 1 minute at 181.4° F. killed all stages of the insect but when the box in which the beetles were held contained ⅛ inch of germea, an exposure of

4 minutes was necessary to be effective, and if there was ¼ of an inch of germea, it was necessary to expose the material for 6 minutes in order to kill all stages of the insect. If the box contained ½ of an inch of germea, 12 minutes were required to kill all stages.

If the temperature was reduced to 176°F, an exposure of 11 minutes was necessary to kill the insects in ¼ of an inch of germea, and 70 minutes were required to produce the same effect at a temperature of 122°F. Six minutes exposure was long enough to kill all of the insects in an open box with no germea.

These experiments seemed to show quite conclusively that the usual sterilization processes as practiced by at least some of the mills, were not killing all of the insects which might be found in the prepared cereals, so we set about trying to find some other more satisfactory method of accomplishing this purpose.

As it is always difficult to keep the steam pressure constant in any sterilizing apparatus, it seemed that it would be much better to use, if possible, a source of heat that could be made constant, and electric heat, of course, seemed to be the most available. After a series of experiments I found that a sheet of metal placed close to coils of electric wire could be heated to a high degree of temperature and this temperature maintained without any care on the part of the operator.

The apparatus that was finally devised for sterilizing such material as germea, corn meal, cream of wheat and other breakfast cereals, consists of three metal plates each with a heating element under it. These plates were placed one above the other in zigzag fashion so that the cereal running from the upper plate dropped on to the second plate and from the second on to the third plate. This provides for the material being turned over a time or two during its descent from the end of the first plate to the end of the third and prevents the material that is on the bottom at the beginning of the sterilizing process remaining in this position during the whole of the process.

The material should be poured on the plates slowly enough so that it will form a thin covering over the plates as it descends. We have found that the material passes over the plates more rapidly and there is less danger of its sticking to the plates if the whole apparatus is subject to some vibration.

We have found that it takes the material that is to be sterilized about 2 seconds to run over these hot plates and as the temperature of the surface of the plate is 300°F. a cereal passing over these three plates

reaches a temperature of from 100°F. to 190°F. depending upon the coarseness of the material. Such coarse material as flaked wheat and rolled oats would require a longer exposure, that is, it would have to pass over more plates before the sterilization would be effective, but such fine material as corn meal, germea and cereals of that type are thoroughly sterilized by this process, all of the stages of the insect including the eggs, being destroyed.

Careful tests made of the material before and after passing over these sterilizing plates shows that material with a moisture content of 10.63 comes from the sterilizer with a moisture content of from 9.23 to 10.10, or an average loss of 1.21%. This, of course, is inconsiderable.

As the material is to be packed soon after it comes from the sterilizer it will be best to screen it before it goes on to the first plate, the size of the openings of the screen depending upon the material to be sterilized. We find that a screen with a mesh .0328 inches in diameter removes all of the adult beetles and all but the smallest larvae from such materials as corn meal and germea. Anything that passes through this screen is so small that its presence can be detected only by the closest kind of examination. Unless the material has been standing for sometime after it was screened, there is very little chance of its being infested with these small larvae.

Summing up then we may say that the chief advantages of such an apparatus as this for sterilizing these cereals is its simplicity, its inexpensiveness, the constant temperature which is maintained without any attention from the operator, the small amount of moisture that is lost in the process, and the fact that the apparatus can be placed in the packing room close to the packing table so that the material can be packed in the containers immediately after sterilization. Experiments have shown that it is perfectly safe to pack the material immediately after it comes from the sterilizer.

Prof. Doane then exhibited a working model of the machine described in his paper.

COTTON BOLL WEEVIL AND THURBERIA BOLLWORM PROBLEM IN ARIZONA

By Chas. T. Vorhies, *University of Arizona, Tucson, Ariz.*

Abstract

The cotton growing valleys of southern Arizona, particularly those about Tucson are of great interest to southwestern entomologists because of the presence in the

near-by mountain ranges of certain potential cotton pests which occur on a native plant, the so-called wild cotton, *Thurberia thespesioides*. These insects are a native variety of the boll weevil, *Phytonomus grandis thurberiae* Pierce, and a noctuid moth, *Thurberiphaga diffusa* Barnes, the larva of which is a bollworm. The native weevil is shown to have habits distinct from the Mexican boll weevil. Both it and the bollworm are well adapted in their life histories to the normal late fruiting habit of the wild cotton. It is believed that either or both might, if proper opportunity were afforded become pests of domestic cotton.

A problem is created by the fact that in the district cultivated about Tucson the wild cotton, harboring both insects, grows quite close to areas on which domestic cotton may be grown. Incipient infestations of the weevil, but thus far none of bollworm, have already occurred in the past few years but have been stamped out. At present there is a controversy to be settled by the courts between the Arizona Commission of Agriculture and Horticulture and the cotton growers of this district regarding the maintenance of a non-cotton area near the natural habitat of Thurberia.

(Paper withdrawn for publication elsewhere.)

THE CITROPHILUS MEALYBUG, *PSEUDOCOCCUS GAHANI* GREEN, AS A MAJOR PEST OF CITRUS IN SOUTHERN CALIFORNIA

By H. M. Armitage, *Entomologist, Los Angeles County Horticultural Commissioner's Office*

Abstract

The citrophilus mealybug (*Pseudococcus gahani* Green) first found in the citrus orchards of Southern California at Uplands, San Bernardino County in 1913, is now established in all of the southern citrus producing counties with the exception of San Diego and Imperial. In Los Angeles, Orange, San Bernardino and Riverside Counties, it occurs over a rather large acreage. In Ventura and Santa Barbara Counties the infestations are new and as yet are confined to a limited acreage though none the less severe in degree of infestation. Due to adverse climatic conditions this species of mealybug has proven less serious in the interior counties as San Bernardino and Riverside and while the spread has continued the infestations have been exceedingly light since the date of the original outbreak. In the coast counties the spread has been rapid and the infestations as a whole very heavy. The citrophilus mealybug is particularly resistant to fumigation and has the usual resistance of this group of insects to sprays. Water under pressure during the peak of oviposition period in the spring is by far the most successful means of mechanical control. Natural enemies of which there are several native species present in the orchards are an important factor of control. The ladybird beetle, *Cryptolaemus montrouzieri* Muls., an introduced predator, is particularly effective. Eight county and Association insectaries in Southern California are producing and liberating monthly over half a million of these beetles, throughout the infested areas of Southern California. Where they are made available in quantity early in the year they are being used successfully as a control measure.

The mealybugs are not new pests to the citrus growers of California. The citrus mealybug (*Pseudococcus citri* Risso) has long been established

in the orchards of the coast counties where it has periodically caused considerable injury to this host. Baker's mealybug (*Pseudococcus maritimus* Ehrh.) and the Longtailed mealybug (*Pseudococcus longispinus* Targ.) have also been of common occurrence on citrus over the same area but can never be said to have been of any real economic importance. With the finding of a new species, (1) the Citrophilus mealybug (*Pseudococcus gahani* Green) at Uplands, San Bernardino County, in 1913, there was added to this group a member which has given evidence of being as serious a pest as the citrus mealybug, if not more so, and is now recognized as one of the major insect pests attacking citrus in Southern California.

The finding of this species at that time was particularly alarming to the citrus growers of the interior valleys as it had been previously supposed that this well-known pest of citrus in the coastal areas could not exist under their hot, dry climatic conditions. While the original outbreaks were rather severe in both San Bernardino and Riverside Counties, the two principal interior citrus producing counties in the Southern part of the State, recent developments have indicated that these climatic factors have a marked restricting influence in those areas, and while its spread has continued no serious infestations have been experienced since 1919. The coast areas however, seem as well adapted to this as to the other established species. Its spread, after once becoming established has been rapid with many serious outbreaks.

The Citrophilus mealybug is a rather omnivorous feeder, resembling *Pseudococcus citri* in this respect, and aside from citrus, attacks a wide range of host plants including many ornamentals as well as fruit trees. In fact, while records are rather indefinite on this subject, this pest was without doubt introduced into the citrus orchards of Southern California on ornamentals either from the vicinity of Los Angeles or from the San Francisco Bay region in both of which areas there is evidence of its occurrence prior to 1913.

General Descriptions

While this species might, from an external examination in the more immature stages be mistaken for the citrus mealybug, the adult female has a distinctive form and appearance which easily distinguishes it from the other species attacking citrus.

Green (3) has given the following very accurate and characteristic description: "adult female thickly coated with greyish-white mealy secretion, which is thinner in the folds of the segments and in the de-

pressed areas. These depressions are in four more or less confluent longitudinal series which are more marked on the posterior half of the body. The darker color of the insect showing through the mealy covering at these spots produces a distinct symetrical pattern." Ferris (4) also calls attention to the "longitudinal rows of impressed dots" as being "quite distinctive." It is this "distinct symmetrical pattern" together, as stated by Green, with the "claret colored liquid in round drops, two close to the head and two close to the tail end, exuded by the insect when irritated" which makes its determination in the field a rather simple matter in the adult stage.

Distribution and Means of Spread

While without doubt, wind and birds are important factors in the spread of this pest, particularly at the time of the peak hatch in the spring, when the minute young are moving freely in the trees in countless numbers, the more probable avenues of spread are through contacts made during cultural operations and the handling of the fruit in the field, particularly as community or association labor crews are in general use. The loose cottony egg masses as well as the freely moving individuals are easily carried on the clothing of orchard workers or on the cultural equipment and the migratory habit of the adult female in searching for a place for oviposition makes the field box an easy carrier from orchard to orchard.

Realizing the seriousness of these avenues of spread the Horticultural Officials in the infested counties have made every effort to control the movement of laborers and equipment between infested and clean orchards. Fumigation of all field boxes before leaving the packing house has been required. Laborers have been supplied with clean caps, jackets, coveralls, gloves and other equipment after leaving infested orchards and before entering clean ones. In many cases owners of infested orchards in comparatively free areas have been required to handle their fruit through packing houses in generally infested areas. In spite of all of these precautions however, the spread has been persistent, particularly in the coastal areas. It is entirely possible that in many cases establishment took place in unobservable quantities before its presence in the south was detected and attempts made to check its spread.

While Clausen (2) recorded less than ten acres at Uplands as being infested in 1915, Woglum (6) shows 600 acres infested in that same area in 1918, in 1922 this had increased to over 1000 acres and a spread was recorded into the adjacent counties of Riverside and Los Angeles. In

Riverside County 100 acres were recorded as infested and in Los Angeles County the infestations were scattered from the coast to the mountains through a belt including Long Beach, Los Angeles, Alhambra and Pasadena.

In the interior areas adverse climatic conditions have tended to delay the spread and to minimize the seriousness of infestations of the past few years. In the coast areas the equable climate has permitted the development of rapidly succeeding and overlapping generations and the spread has been alarmingly rapid with many serious outbreaks. The map of Southern California at the present time shows, aside from the previously mentioned areas, a general distribution over Orange County, about 3500 acres infested in Los Angeles County and heavy established infestations at Oxnard in Ventura County and at Carpenteria in Santa Barbara County. In fact it now occurs in all of the citrus producing counties of the southern part of the State with the exception of San Diego and Imperial. In Orange County the infested acreage has increased from a few scattered trees over 10 acres in 1921 to over 8,000 acres this season.

Though the distribution is wide spread, as yet less than 5% of the total citrus acreage of Southern California is actually infested. The location of this infested acreage, however, is such that it forms a potential source of spread to an exceedingly large adjacent acreage.

Seasonal History

In the interior valleys in which the original observations were made by both Clausen and Woglum as well as the writer (5) the seasonal history is confined to a heavy conspicuous generation in May and June preceeded by a light generation in February and March and with light succeeding and slightly overlapping generations during the summer months, increasing in intensity during the fall. Overwintering is carried out in the intermediate stages on citrus, under the buttons or in depressions in the fruit or between fruit clusters. Summer temperatures are without question responsible for a high mortality among the progeny of the heavy May and June generation which accounts for the light succeeding generations, with a slight increase as the weather moderates in the fall.

With the advent of this species into the coast areas, however, we have an entirely different situation. While in the main, the periods of occurrence of the succeeding generations are similar to those in the interior areas, the mild climatic conditions permit an increased develop-

ment with a marked overlapping of generations. Instead of a peak migration of adult females to the trunks of the trees—a characteristic of this species of mealybug—in May and June, we have a more or less continuous migration throughout the summer months. Starting with a rather well defined, though light generation in March, the increase in intensity is rapid and the generations are soon lost sight of due to overlapping. A peak is reached about June 1st, which is maintained throughout the season or until control is established.

Effect on the Host

In passing along the road there is little external evidence of a sometimes severe infestation of this species in an orchard with the exception of the presence of the usual "sooty mold" fungus developing in the exuded honey dew. A close examination of the infested trees, however, would show a heavy defoliation and killing of small wood in the interior of the trees. This condition late in the season might extend to the outside of the tree though such a condition is exceptional as control is usually secured before the injury extends that far.

Probably the most serious phase of an infestation of this species is the migration of the hatching young from the egg masses on the trunk in May and June to the stems of the young fruit which is just in the stage of "setting," exaggerating an already serious seasonal field condition known as "June drop." This condition is further exaggerated on Valencia orange trees due to the fact that the previous season's crop is still on the trees and the old fruit clusters hold adults and egg masses in close proximity to the newly setting fruit, insuring a higher percentage of young reaching it. In the case of severe infestations a large percentage of this new crop is lost before control can be established. Another avenue of loss in the case of Valencia oranges is through the collecting of individuals about the stems of mature fruit and through their feeding so weakening the stem that a heavy drop is caused.

Though the greater part of the present infested acreage is planted to oranges, the lemons and the pomelo have demonstrated their susceptibility to the attacks of this pest with a similar form of injury.

Relation to Ants

Ants, particularly the Argentine Ant (*Iridomyrmex humilis* Mayr) are recorded by Woglum as being present without exception in every case of severe infestation. This may have been true at the time his

observations were made, but recent developments have shown this species fully capable of reaching a stage of severity without the attendant protection of the ant. In Orange County less than 25% of the 8,000 infested acres is attended either by the Argentine Ant or by native species. In the Rivera section of Los Angeles County where at present the most severe infestations of that species in that area occur, less than one percent of the 1,000 infested acres is attended by ants.

This ability on their part to maintain themselves in the absence of ants, is not due to any lack of natural enemies from which the ant might protect them as this species is attacked by the same group of predators as the other citrus feeding species with one exception, the brown lacewings (*Sympherobius* spp.) and even these seem to be adapting themselves to this host as each season they are found more often feeding in the egg masses.

I do not intend to minimize in any way the need of controlling ants where ever they attend infestations of mealybug but merely to point out that at least this species is not entirely dependent on their protection for its existence.

Control

Mechanical Treatment. This species of mealybug has been reported by Clausen as being the most resistant to cyanide fumigation of any of the species attacking citrus, and it is a well known fact that none of the others can be successfully controlled in the field by this method. In the laboratory, using a gas tight box with a capacity of twenty-five cubic feet Clausen was able to secure a one-hundred per cent kill of all stages using a 70% schedule for one hour. The eggs succumbed to a 50% dosage and the adult females to a 60% dosage. The larvae and male pupae required 70%. More recent tests by Woglum in the treatment of infested cull oranges intended for byproduct purposes, when applied on a large scale, even in a practically air-tight room required 3 ounces for two hours or four ounces for one hour, to guarantee a 100% kill of all stages. It has been fully demonstrated in the field that a maximum dosage which may be administered in the field with safety to the tree is not sufficient to give a satisfactory commercial kill of any of the mealybugs, nor is this species any exception to the rule.

The citrophilus mealybug has the usual resistance of all other species to sprays due to the impervious coating of waxy secretion. Sprays containing an ingredient which will penetrate this wax usually are injurious to plant life and are not practical for commercial use.

A peculiar habit of a large percentage of the adult females of this species in descending to the trunk and main limbs of infested trees for the purpose of oviposition appears to offer an easy point of attack. Concentrating in heavy masses in the crevices of the trunk and under trap burlap bands, placed around the trunks of infested trees, at certain periods of the year, their removal at that time would seem to offer a very satisfactory means of control. This is partly true in the interior areas where as previously stated, adverse climatic conditions confine this mealybug to a single heavy generation or migration to the trunks in the spring, with very light succeeding generations. Under such conditions a trunk treatment might be applied economically. In the coast areas, however, the more equable climate permits a continuous development of overlapping generations which means a more or less continuous migration of adult females to the trunks, precluding an effective single treatment. Repeated treatments have been demonstrated to be of little value and the cost prohibitive. In the case of Valencia oranges where the previous year's crop is often held on the trees several months after the new crop has set, the clusters of old fruit serve as suitable places in which the adult females cluster for oviposition, further detracting from the value of trunk treatment. While oil emulsions have been used safely in these trunk treatments where conditions suggested the value of trunk treatment it has been fully demonstrated that water applied under pressure is fully as effective and does not materially interfere with the work of the many natural enemies which attack this pest.

Biological Control. While there are many native insect predators of the Citrophilus Mealybug present in the citrus orchards of Southern California, a practical application of this method of control is being carried out successfully, using an introduced coccinellid, *Cryptolaemus montrouzieri* Muls. Appreciating the fact that successful commercial control using this method is dependent on systematic quantity liberations of an effective enemy at a period in the year which will permit several months of continuous uninterrupted activity, laboratory work has been developed during the past few years which makes it possible to meet these conditions. The Cryptolaemus, introduced into California in the early '90s by Koebele of the United States Department of Agriculture has been selected for this work for several reasons. It had already demonstrated its ability to control the citrus mealybug (*Pseudococcus citri*) when introduced into an infested orchard and was determined as being equally effective against the present species; as a

predator it fed extensively in both the larval and adult stages; it has, so far as known, no enemies of its own in the form of secondaries established in California,—this cannot be said of the several very efficient native enemies which are heavily attacked by a number of secondaries and checked at the time they are approaching controlling numbers, in the field; and last but very important it lends itself readily to rearing in the laboratory.

Following methods worked out and using equipment developed by the California State Department of Agriculture, five county and four associations and privately owned insectaries are at the present time producing and liberating in the citrus orchards of Southern California over 500,000 of these beetles, monthly.

Liberations are being made on a community basis and cost of production is being met by owners of non-infested as well as those of infested groves on a basis of orchard protection. Systematic liberations are being made which calls for the placing of a reasonable colony of these beetles on each infested tree in the district as early in the season as field conditions will permit uninterrupted development. With a short life cycle averaging thirty to forty days and an average increase of two hundred per generation, control is assured within sixty to ninety days, this being a sufficient length of time in which to step themselves up to controlling numbers. Heavy infestations, due to the abundance of food material available, are most easily controlled. However, with a surplus of these predators created in an infested district, as a whole, the greater part of the infestations can and are being prevented from ever becoming serious. This method is the one which is being followed successfully and almost universally in California at the present time, both in the interior and in the coast areas.

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Prior to adjournment President Burgess gave an informal talk on various matters pertaining to the relationship between branches, sections and the parent association.

Friday Afternoon Session, June 28th, 1924

Chairman Smith called the meeting to order at 1:30 P. M. and called for the following papers:

LYGUS ELISUS ON COTTON IN THE PACIFIC REGION

By E. A. McGregor, *Bureau of Entomology, Lindsay, California*

(Withdrawn for Publication elsewhere)

PRELIMINARY REPORT ON THE USE OF CALCIUM CYANIDE AS A SOIL FUMIGANT FOR WIREWORMS

By Roy E. Campbell, *U. S. Bureau of Entomology, Alhambra, California*

Abstract

In a series of preliminary pot and field experiments calcium cyanide, used at the rate of from 130 to 400 pounds per acre, showed a decided toxicity to wireworms, Elaterid larvae, and indicated that about 200 pounds per acre if properly applied would kill 75 per cent, or more, of the worms.

Wireworms[1] have caused enormous damage to various crops on the Pacific coast for a number of years, particularly to beans, beets, and potatoes, but to many other crops as well. Many attempts have been made to control these pests, but none has proved satisfactory. One entomologist expressed his opinion that "wireworm control is a problem which we can leave for posterity to solve." With the constantly increasing damage from wireworms, however, it is becoming apparent that the discovery of some method of control can not wait on posterity.

It has long been known that hydrocyanic-acid gas derived from sodium or potassium cyanide would kill wireworms, but its use was impractical because of its high cost and its injury to plant life. The development of the low-grade and comparatively cheap calcium cyanide removes the first objection to the use of hydrocyanic-acid gas, and the use of the material when the ground is fallow, or prior to planting, eliminates the second objection.

In order to test the effect of Calcium cyanide on wireworms, a series of experiments was undertaken in the laboratory at Alhambra, Calif., in

[1]The species principally concerned are *Pheletes californicus* in Calif. and *P. occidentalis* in Washington.

June, 1923, 10-inch pots of soil being used, followed, in August, by field tests at Toppenish, Wash.[2]

In the pot experiments, various types of soil were used, as well as moist, dry, loose, and packed soil, and the relative locations of the cyanide and wireworms were also varied. A summary of all of the experiments show the following:[3]

TABLE I—SHOWING PERCENTAGE OF WIREWORMS KILLED BY DIFFERENT AMOUNTS OF CALCIUM CYANIDE DUST PER ACRE IN POT EXPERIMENTS AT ALHAMBRA, CALIFORNIA, IN 1923

Pounds per acre	Per cent killed Maximum	Minimum	Average	Number of experiment	Total number of worms used
400	100	70	92	9	90
350	100	30	80	12	120
300	100	30	71	12	120
250	90	30	65	12	120
200	100	10	50	13	130
150	90	0	40	11	110
Control[4]	10	0	1	9	90

Although nearly a hundred experiments were performed, they were not considered sufficient to explain entirely the variations in results. An analysis of the experiments, however, suggests the following factors as having a bearing on the success or failure resulting in several cases:

(1) DEPTH OF CYANIDE. Following shallow applications, there remained in the pots a considerable percentage of live worms, nearly all of which, except in the case of light dosages, were several inches below the cyanide. It was therefore concluded from the rather meager evidence that the killing of few wireworms below the cyanide could be expected.

(2) MECHANICAL CONDITION OF THE SOIL. In experiments where the soil was left very loose, the killing in most cases was low, probably owing to the fact that the gas was allowed to escape too rapidly. Where the soil was packed hard, also, the killing was low, owing to the difficulty with which the gas penetrates soils in this condition.

(3) ACTIVITY OF THE WIREWORMS. As the experiments continued into the fall and the wireworms became less active, results showed

[2]The experiments at Toppenish were carried on under the writer's direction by Mr. John N. Stone.

[3]In these experiments calcium cyanide dust was used, while for field work the granular form was used.

[4]Of the 90 worms used in the controls, 86 were recovered, 85 alive and 1 dead. However, in none of the experiments were missing worms considered as having been killed. In computing the percentage of killing, only the dead worms actually recovered were used.

lower killing, even with the higher dosages. It may be that as the wireworms become less active the effect of the gas upon them decreases.

Results obtained at Toppenish, Wash., gave considerable promise, but difficulties were encountered owing to the lateness in the season, the hardness of the soil, and the increasing inactivity of the wireworms. Benefited by the experience gained in the fall, the experiments were begun at the first signs of wireworm activity in the spring, which was early in March. A special machine was designed by the American Cyanamid Company which could be attached to the beam of a plow and set to feed a definite amount of cyanide in the furrow just ahead of the soil which is being turned over. Disc and hoe drills also were used in the application of calcium cyanide. Soil examinations were made both in the plots and in other parts of the infested fields. The percentage of killing was ascertained by sifting several cubic feet of soil in each plot and counting the dead and live insects. A summary of the experiments up to May 5 shows the following results:[5]

TABLE II—SHOWING PERCENTAGE OF WIREWORMS KILLED BY DIFFERENT AMOUNTS OF GRANULAR CALCIUM CYANIDE, TOPPENISH, WASHINGTON

Pounds per acre	Per cent killed Maximum	Minimum	Average	Number of experiments	Total number of worms found
350–500	100	100	100	4	35
280–300	100	71	93	6	141
225–250	100	77	89	5	58
180–200	100	21	73	11	335
130–150	81	16	49	8	154
Control	0	0	0	21	579

Here again it is at present impossible to explain the variations in results but a study of the experiments suggest several contributing factors, among which are the following:

(1) TEMPERATURE. During low temperatures the wireworms are inactive and probably not so greatly affected by the gas as when active.

(2) MOISTURE. In several of the experiments where poor results were obtained the soil was wet. It is well known that moisture will absorb hydrocyanic-acid gas and that when too much moisture is present the calcium cyanide breaks down, forming ammonia and thus lessening the amount of hydrocyanic-acid gas given off. Probably this is what happened in some of these experiments.

(3) METHOD OF APPLICATION. In most cases better results were

[5]The type of soil at Toppenish is volcanic ash loam, and was practically uniform in all plots, varying only in its mechanical condition.

obtained with the drill, which placed the cyanide in the soil in rows 6 or 8 inches apart, than with the plow applicator, which placed the cyanide in rows 14 to 16 inches apart.[6]

(4) TEXTURE OF SOIL. Too loose or too compact a soil also seemed to be the cause of poor results.

(5) DEPTH OF APPLICATION. This appears to be very important, for equally poor results were obtained when the cyanide was placed too near the surface and when it was placed too deep. The depth at which the majority of the wireworms occur seems to determine the proper depth for applying the cyanide. This depth appears to vary throughout the season but the habits of the worms have not been sufficiently studied so that it can be predicted with certainty. In most of the experiments, however, the best results were obtained when the cyanide was applied from 4 to 6 inches deep.

The experiments so far have not determined whether it is best to apply the material early in the season, or as late as possible, just prior to planting, but indications are that late spring will be the best time. In early spring the worms are not only more or less inactive, but are fairly deep in the soil. When the soil warms up they become quite active and feed near the surface, but with the advent of hot summer weather, they go deeper in the soil again. Screening of a number of one-foot cross sections of soil in the last of February showed that 46 per cent of the worms were in the upper 4 inches, 40 per cent from 4 to 6 inches deep and 14 per cent from 6 to 8 inches. On May 5, however, 73 per cent of the worms were in the upper 3 inches and 90 per cent in the upper 4 inches.

During cold weather worms turned up by the plow show very little activity, remaining at the surface, often exposed for some time, but in warmer weather such worms rapidly work back into the soil. In the Yakima Valley early applications also killed many adults which had not as yet emerged from the soil.

To determine how long the cyanide remained in the soil, definite applications followed by chemical analyses were made, with results as follows: No cyanide could be detected in a wet soil[7] after 2 days when 150 pounds per acre had been applied and none after 4 days following an application of 500 pounds to the acre. In a dry soil[7] a faint trace of cyanide could be detected on the fourth day after using 150 pounds per

[6]The use of the applicator on 8 or 10-inch bottom plows, or with a spreading device, would remove this difficulty.

[7]The wet soil had more and the dry soil less than the optimum amount of moisture for cultivation or planting.

acre, and on the tenth day when 500 pounds per acre was used. The quantity toward the end of the period was extremely small in each case. These data indicate that the cyanide remains in the soil for only a short time, and that it will be perfectly safe to do the planting within a week or 10 days after application. These results have been confirmed by field experiments. Seed potatoes planted immediately or the next day after a calcium cyanide application were all injured, but when planted a week or more after the application they showed no effect from the cyanide.

The application of calcium cyanide to soil in which plants, such as potatoes, bulbs, and young seedling trees, were growing, demonstrated that when it was placed close enough to the plants or used in quantities sufficient to get a good killing of wireworms, injury to the roots or tubers resulted.

On only one experimental plot are the plants sufficiently advanced in growth at this writing to show the effect of the treatment on the crop. A treated potato plot on badly infested soil shows a decidedly better stand and growth than the untreated adjoining areas. This not only indicates that the wireworms were controlled, but also that the calcium cyanide did not injuriously affect the soil for subsequent plant growth. Practically all plots have been planted to some crop, and examinations will be made during growth and at harvest to determine how effective the treatment has been in increasing the quantity or improving quality.

The experiments so far have been intended primarily to determine whether calcium cyanide will kill a satisfactory proportion of the wireworms when applied in moderate amounts. They indicate that 200 pounds per acre if properly applied will kill 75 per cent, or more, of the worms at a cost of about $30 per acre. It should be borne in mind that the benefit of one treatment will extend over two or three years at least,[8] owing to the fact that it requires about three years for these wireworms to reach maturity and a single brood may cause injury over this period.

Experiments are now under way to discover means of reducing the amount of cyanide required per acre and thereby the cost of treatment. It is a well-known fact that wireworms collect in the rows of beans or other crops; therefore, if advantage is taken of this habit by drilling in split beans, rice bran, or other attractants, to induce the wireworms to concentrate in rows 2 or 3 feet apart, and subsequently treating these rows with a fairly heavy application of cyanide, a better killing may be

[8]In addition to controlling the wireworms, there is some evidence that the use of calcium cyanide increases the nitrogen content of the soil.

obtained with less material per acre. Improvements in methods of application are also under way, as well as experiments to ascertain the proper depth of application, distance between treated rows, best time to apply the cyanide, etc.

The calcium cyanide used in the field experiments was the granular form, which is the ordinary flakes ground to about the fineness of coarsely ground coffee and the finer particles sifted out and discarded. This material feeds readily from grain and small seed drills, is more conveniently handled and applied and appears to give better results than the finely ground dust.

CONTROL OF THE APPLE BLISTER MITE IN THE NORTHWEST

By Leroy Childs, *Hood River, Oregon*

(Withdrawn for publication elsewhere)

CITRUS SPRAYING IN TULARE COUNTY

By A. F. Kirkpatrick, *Lindsay, California*

(Paper not received for publication.)

NOTES ON AN OUTBREAK OF CUTWORMS

By S. J. Snow, *U. S. Bureau of Entomology, Salt Lake City, Utah*

(Paper not received.)

The following papers were read by title:

SPRAY STIMULATION

By Frank B. Herbert, *Assistant Entomologist, Balfour Guthrie & Co.*

Abstract

Stimulation to deciduous fruit trees has been noted from a number of different sprays, but the greatest amount has occurred after using the heavy types of Miscible oils.

Stimulation is due partly to the heavy oil base and partly to the emulsifiers in them.

The condition of the tree and soil and time of spraying are factors in the amount of stimulation to be obtained from the oil spray. The spray must be applied between December 15th and February 1st to be certain of it.

Although there may be some disadvantages, the advantages are many such as: 1. The early bloom makes the fruit set early, thereby coming ahead of the emergence of

the Thrips, insuring more and cleaner fruit. 2. Causes early formation of large green leaves, covering small fruit, protecting it from sunburn and frost. 3. The fruit gains much of its growth before natural moisture evaporates. 4. Causes tree to function properly, producing larger crops and larger fruit, and 5. Fruit will be harvested earlier, insuring better prices.

Examples cited and photographs.

Stimulation to fruit and foliage has been noted from time to time from the application of dormant sprays. Lime Sulphur Solution and Bordeaux Mixture have been mentioned by growers and investigators occasionally but the oil sprays are mainly responsible for this stimulation.

Lime Sulfur Solution will occasionally show a slight stimulation to prunes or pears, but has a decidedly opposite effect upon apricots if applied late in the spring, causing the fruit to ripen late and both fruit and foliage to be small and yellow. Apricot trees are very susceptible to sulphur poisoning in all forms, with one exception. The writer has never seen Barium Sulphur (BTS) retard the growth of apricots or any other variety of fruit. In fact, it seems to be a very fair stimulant.

Bordeaux Mixture applied to deciduous fruits, particularly in the fall, will often have a noticeable effect in hastening the bloom in the spring.

Oil Sprays

Oils very often cause a more distinct hastening of the bloom and ripening of the fruit than any other spray. This has been noted with the heavier types of emulsions and miscible oils and very seldom with the lighter types made from kerosene or distillates. These lighter oils gave some stimulation in the spring of 1924, which was a very abnormal year with a very light rainfall. The reason that the lighter types do not generally cause stimulation is due in the main to the fact that they evaporate too quickly and are not on the tree long enough to give any lasting benefits.

With the heavy types of oil this effect has been very pronounced, more so with the true Miscible oils than with the ordinary emulsions.

By the term Miscible oils is meant an oil containing liquid emulsifiers, particularly Cresylic Acid, the finished product resembling an oil in appearance. Some paste type emulsions have been called Miscible oils or Miscible Type oils simply because they turn white like miscible oils when added to water, but this is apt to cause some confusion.

The stimulation from the oils is partly due to the emulsifiers, also, as a heavy oil emulsified with a mineral salt or colloidal material does not

usually give the same stimulation that one emulsified as a Miscible oil does. In fact, certain makes of Miscible oil will show this more than others.

Balfour Guthrie & Company manufacture a full line of Miscible oils and under the leadership of their entomologist, Paul R. Jones, have made an exhaustive study of the proper types of oil and emulsifiers for the best stimulation and Scale kill, and yet retain a high safety factor. Probably no other concern has the knowledge of the manufacture and field use of oil sprays that this company has. One reason for this is that they have been manufacturing oil sprays for some twelve or thirteen years and Mr. Jones, and the writer as well, had a number of years experience previous to this while working for the United States Government. There are certain ingredients in their Miscible oils which are not found in any other brand, at least not in the same proportions.

Conditions Necessary

Certain conditions must exist in the orchard before this stimulation will take place.

The amount of moisture in the soil is one of the most important factors, therefore, the spraying should not be done until several inches of rain have fallen within a few weeks previous to the application. There must be plenty of plant food available in the soil.

Naturally, one can not expect to obtain a crop by spraying only. The grower must give the orchard proper pruning, irrigation and cultivation together with the spraying for the best results.

In the California coast counties the proper amount of moisture will generally be present by early December. However, in 1923 the work did not start until the latter part of December, due to lack of moisture. Therefore, the work should be done from early December to the last of January. Although the stimulation has taken place at various times from materials applied throughout February, still one can not count on its happening from so late an application. Often too late an application will retard blossoming.

Effect of Stimulation

The effect of the stimulation is to cause a vigorous early bloom, varying from five to twenty days earlier than normal, according to the dosage, time, weather and condition of the orchard.

Prune growers in the Santa Clara Valley have found that a full bloom appearing before March 20th insures one of a good crop; appear-

ing from March 20th to April 1st presages a fair crop and a bloom after the first part of April means a poor crop. On the whole this seems to hold good.

Disadvantages

Some growers argue that the sprays will hasten the bloom so much that it will make them more liable to injury from frost. This has not been noted in the Santa Clara Valley by the writer, but this might happen once in a great while with some varieties of fruit in certain localities. If one does not want to obtain the early bloom he can spray rather late and clean up his trees from pests with practically no stimulation ordinarily.

Others argue that there will be a reaction to excessive stimulation, yet nothing of the sort has been noted to date on orchards that have had an annual treatment for four and five years in succession. In comparison, there are non-poisonous stimulants, such as spirits of ammonia, administered to human beings with no apparent detrimental reaction. so that the same should apply to plants as well.

Excessive dosages of spray material may cause a retardation instead of a stimulation when applied under some conditions. This is to be expected as it is true of practically any stimulant when applied too freely.

Advantages

Some growers are spraying with an oil spray every season in order to obtain the benefits to be derived therefrom. This applies particularly to prune, apricot, and cherry growers.

1. The early bloom causes the fruit to set before the Thrips appear, thereby giving more and cleaner fruit in sections where this insect is a problem.

2. The spray causes the foliage to grow very fast, covering the small fruit and protecting it from sunburn and frost.

3. Moreover, the fruit attains much of its growth before the natural moisture has evaporated from the ground.

4. The early vigorous bloom produces an earlier harvest, thereby reaching the market in time for better prices.

5. It will cause larger crops of larger fruit. This is probably due partly to having the tree free from pests, thereby being able to function properly; partly to obtaining its growth early before the hot weather sets in to retard it; partly to the large dark green leaves which the tree obtains early; besides the direct effect of the stimulation.

1. Noah G. Rogers prune orchard, Los Gatos, California. The trees on the left sprayed with Dormant Soluble Oil, bloomed nearly three weeks earlier than those unsprayed on the right. There is a large difference in the crop as may be seen from the photo below.

2. Noah G. Rogers prunes. Los Gatos, California. Sprayed with Dormant Soluble Oil on right, unsprayed on ieft.
Photos by Frank B. Herbert.

Examples

A good example of the latter is the Van Dorsten and Lester orchard near San Jose, California. They doubled the number of prunes per tree on the area sprayed in the spring of 1923 over the part of the orchard not sprayed. The prunes on the sprayed area ran ten to fifteen points larger, too, which would not be expected normally, for a tree with a larger crop usually produces smaller fruit than one with a small crop.

One advantage of the early harvest has been noted by the Losse Brothers on their 150 acre apricot orchard near Sunnyvale, Calif. They have found by spraying half the orchard with heavy miscible oil that they can nearly complete harvesting their fruit on this half before the other is ready, thus greatly reducing their labor problem which is often a real factor with so large a ranch.

Dan Regan, on the Blauer Ranch near Saratoga, California, has sprayed his apricot trees with heavy miscible oil for four years in succession now and each year he has produced an early crop of large, clean fruit, which the canneries are anxious to obtain for they can dispose of this fruit before the bulk of the fruit throughout the Valley is ready to can.

E. B. Stone has been using heavy miscible oil on his prune orchard near Campbell, California, for five years in succession now and he feels that the spray has "put the dollars on his trees" every year. These last two cases certainly show that the continual use of oil does not injure the tree or crop in any way.

Another example of a large crop increase should be noted in the Rhoades Ranch near Morgan Hill, California. On the place are fifty-five acres of nine and ten year old prune trees which heretofore have never produced more than twenty-six tons of green fruit. This season, after its first spraying, it is estimated that the crop will consist of at least two hundred and twenty tons green, or approximately ten times greater than what it has ever produced before. Some may say this is because the trees are now at the right age to bear and it is true that they are. However, every tree on the ranch, from three to ten years old, that was sprayed, now has a heavy crop of large fruit, showing that age has very little to do with it.

A. N. Kellner, Edenvale, sprayed his prune orchard in early 1923 and had a crop which averaged nine green tons per acre, while the average through the Valley was but one ton per acre. He sprayed part of the orchard again in 1924 and has a much larger crop on the part sprayed as compared with the unsprayed.

There might be added to the above names a long list of growers in the Santa Clara Valley who have increased their crops by spraying with heavy miscible oil, but the above should be sufficient to convince the most skeptical.

LIFE HISTORY AND BIOLOGY OF *ECHOCERUS CORNUTUS* (FAB.)

By David Shepherd, *Stanford University*

Abstract

Echocerus cornutus, a cosmopolitan bran beetle is found injuring cereal products. A description is given of the various stages of the insect together with notes on life history and food habits.

Results of experiments to test the attraction of water for these insects and the effect of air-tight sealing on the life of the insect, and the effect of humidity on the rate of development, are given.

Echocerus cornutus is cosmopolitan in its distribution but according to available data is injurious to cereal products, in the United States, only in the coast and bay regions of California. In spite of its economic importance, the literature dealing with this Tenebrionid has done little in furnishing information as to its life history or general habits and for that reason the following condensed account of the study and observations of this beetle is given.

The Egg. The egg is oval elliptical in longitudinal section and its size when coated depends upon the size of the particles of the material in which it is deposited, the actual measurements showing it to vary from .48 mm. to .51 mm. in width and from .85 mm. to .93 mm. in length.

When first deposited the egg is of a pure white glistening color, covered with a viscid substance showing a series of fine lines circling it radially, this being its complete sculpturing. After the egg has been deposited for some time it changes in color from the pure white to a straw color.

The eggs are ordinarily found among the particles of material in which the beetles live. In some instances they have been found adhering to the side of the carton or container in which the material has been placed.

The Larva in its Last Instar. The larva in its last instar is elongate, subcylindrical, convex dorsally and slightly convex ventrally. In color it is yellowish, the ventral surface being lighter in color than the dorsal. The head and the posterior portion of the larva are darker in

color than the rest of the body. The head is a pronounced brown, the edges of the mandibles are black and the bases of the mandibles are slightly brown. The claws on the legs are slightly brown and the spines show some little pigmentation.

The head is subquadrate, quite convex and bears six stout hairs on the lateral dorsal surface. The eyes appear as two almost spherical spots on the anterior lateral part. The antennae are pale yellow in color, showing a basal segment, a large second segment followed by a smaller segment which in turn bears a bristle.

The mouth-parts are directed ventrally. The labrum is large, the basal joint trapeziform and the terminal joint rounded bearing several small hairs on the margin. The mandibles are large, heavy and visible from above. The labium does not cover the mandibles, the labial palpi are cylindrical in form and two-jointed. The maxillae are longer than the labrum, the maxillary palpi are three-jointed, having a rather short basal joint, a second joint longer than the basal joint and a third joint papilliform. The submentum is larger than the mentum.

The thoracic legs are rather stout, the first pair being longer than the second and third pairs. On each leg there is borne a terminal hook, the tarsus bearing two short spines on the inner distal margin, the tibia bearing three marginal spines and the femur bearing four spines.

Each abdominal segment bears six spines. The caudal segment, which is scutelliform, is slightly convex dorsally and convex ventrally, bears four spines on its terminal dorsal margin and six spines on either lateral margin.

Pupa. The pupa ordinarily measures 3.6 mm., in length with a head measurement (width) of 1.35 mm. It is slightly arcuate dorsally, flattened to slightly concave ventrally. In color it is entirely white when emerging with the exception of the pigmentation of the eyes and mandibles which increases rapidly. The head is pressed into the prosternum, the pronotum is very broad and even with the head, making the head invisible from above. The mesonotum is narrow and scutelliform, the metanotum saggitiform and about as broad at the anterior margin as the mesonotum.

Seven abdominal segments are visible. The caudal segment bears a pair of posteriorly directed spines near the posterior margin dorsally, and a pair of median anal lobes ventrally. The first six abdominal segments bear lateral lobes each supplied with two setae.

The head, legs and antennae of the pupa are free, the antennae passing behind the first and second pairs of legs and over the base of the wing

pads. The elytra are folded ventrally but not over the legs. The lateral hairs remain on the abdominal segments.

The sexes of *Echocerus cornutus* are easily distinguished in the pupal stage, the female possessing a pair of appendages on the terminal abdominal segment while the male presents only indistinct elevations in this region.

THE ADULT. The adult is shining reddish brown in color and has a length of about one-eighth of an inch. The head is restricted behind the eyes so as to be drawn into to the prothorax nearly to the eyes, is narrower than the thorax and is densely punctured.

The eyes are dark, deeply emarginated and extend underneath the head. The antennae are clavate and sparsely covered with hairs. The mandibles of the female are short and of the usual type but the mandibles of the males are very conspicuous in that they are broad and expanded at the base but as they extend forward they taper to a point, being curved distally. Another marked difference between the male and the female is the presence of two prominent tubercles in the center of the head of the male.

The prothorax is rectangular and margined by a deep groove, the anterior angles being slightly rounded and the posterior angles sharply curved, wider than long, flattened dorsally and densely punctured with round pits.

The middle coxa is without a trochanter, the hind coxa separated, the tarsi pubescent beneath with the last joint much elongated.

Each wing cover has six narrow longitudinal depressions with ridges in between. In each depression is a row of shining black punctures, the entire under surface of the elytra is also punctured. The posterior portion of the abdomen under the elytra is black.

LIFE HISTORY. The eggs of the beetle were laid singly and within twelve hours after copulation. These eggs hatch under a temperature of 76°F. in ten days. The larva in emerging from the egg appears to cut its way from the egg case and emerges through a round opening in the end. Preparatory to its first molt, it is inactive and the body seems to contract giving the whole a somewhat unnatural aspect. The larval skin splits dorsally for its entire length and is usually left away from the meal. As soon as the larva passes thru its first molt it commences feeding again. If feeding on germea, the length of the second instar is six days, the third instar six days, fourth instar four days, fifth instar nine days, sixth instar seven days, eighth instar five days, the ninth and last

instar lasts for a period of fourteen days, two of which are spent in an inactive condition which I choose to call a prepupal stage.

FOOD HABITS. I have found, during my observations, *Echocerus cornutus* feeding in flour, corn meal, germea, dog biscuits, corn, pancake flour, yeast cakes, bran and farina. By means of tests it has been demonstrated that these beetles show a preference for flaky material and this choice may be linked up with the tactile responses of the beetle.

DAMAGE TO FOODSTUFFS. The chief damages to foodstuffs occasioned by the presence of *Echocerus cornutus*, are the presence of either living or dead insects, either in larval or adult form; the presence of cast skins; the loss of material eaten during growth and the presence of accumulated dust and frass.

ATTRACTION BY WATER AND MOISTENED MATERIALS. In some tests to determine whether or not these beetles were attracted by water I found that even in the face of a mechanical difficulty they would make an effort to get to the water. So pronounced was this attraction that my interest was aroused in determining whether or not moistened material would be as attractive as the water. Accordingly I mixed some water, with meal and in comparing the infestation of the moistened material with that of the dry there was shown a very decided preference for the former. Believing that some use could be made of this preference in the mixing of bait and using arsenicals as one of the ingredients, some poisoned material was prepared by the use of Paris green and arsenious acid. The result of experimentation with 100 beetles went to show that there was a decided preference for the moistened material. The material poisoned with Paris green acted somewhat as a repellent, more dead and living beetles being found in the meal poisoned with the arsenious acid. At the end of sixty-five hours but fifteen live beetles remained.

EFFECT OF AIR-TIGHT SEALING ON ECHOCERUS CORNUTUS. Even today the opinion is rather general that "bran beetles" or "Weevils" can live almost wholly independently of ventilation and that a non-ventilated atmosphere, of a somewhat optimum temperature and amount of water vapor provides the most favorable condition for the reproduction of the insects. In the light of experiments performed, such ideas are entirely erroneous. Adult beetles, *Echocerus cornutus*, succumbed to the lethal effects of air-tight sealing in the short period of five days and the larvae of the same beetle succumbed, under the same conditions, in from five to ten days.

While conducting certain tests notice was taken of the mortality suffered by these beetles when confined in open vessels containing food,

and apparently living under favorable conditions as regards humidity and temperature. To supply a possible explanation for the same a rather long line of tests was conducted by supplying food materials in varying amounts to open mouth bottles and introducing into this food a definite number of beetles; a careful count to be made of the mortality rate at different intervals of time. As a result of these tests it was shown: that apparently the greater the air space, the more pronounced the increase in the rate of mortality. As a check upon these tests two other experiments were determined upon: one by supplying mechanical means for making it possible for the beetles to maintain a position near the opening of the mouth of a bottle containing little food and the other, by means of an air suction pump to supply a constant change of atmosphere to a bottle containing a small amount of food. These and the other tests mentioned indicated that some factor or factors entered to bring about a lethal effect upon the adults of these beetles, and these were more or less dependent upon the amount of atmospheric space above the meal and below the opening of the mouth of the bottle, unless a constant change of atmosphere was supplied in which case the rate of mortality was lowered.

A number of factors to account for the above might be suggested,—carbon dioxide, a gas heavier than atmosphere and a gas given off during respiration of the beetles or grain, a diminished oxygen supply, a gas or gases as yet unidentified, are within the limits of possible causes.

Following the suggestion that CO_2 may be the toxic substance and possibly its source, the product of the meal in which the beetles were kept, this meal was heated to 115°C. for one hour to make ineffective the enzymes for CO_2 production, it was found however, that the rate of mortality of beetles living in that material was higher than that of beetles living in unheated material, so if CO_2 is the toxic substance it must come as a product of the metabolism of the beetles.

Effect of Humidity on the Rate of Development of Echocerus cornutus. Headlee, Parker and others have shown that humidity has an effect upon the rate of metabolism of insects. In order to determine in a general way, the effect of varying degrees of humidity on *Echocerus cornutus* I designed the following experiment. One hundred and twenty-five adult beetles, and one hundred larvae in last instars, were placed in open cartons containing germea and then placed under bell jars under varied moisture conditions, the humidity of the bell jars being controlled by drawing air thru a calcium chloride dryer, which gave it a humidity of less than 1% and then passing this thru concentrated solu-

tions of calcium chloride giving the atmosphere a humidity of approximately 25%; copper nitrate approximately 45%, sodium chloride 75% and thru distilled water approximately 100%. Atmosphere of room humidity was introduced into one of the bell jars and atmosphere drawn thru a calcium chloride dryer was introduced directly into another bell jar. The atmosphere was taken from the bell jar having the selected percentum of atmospheric moisture to a constantly functioning suck pump.

Using the following as an index as to the effect of the different percentages of moisture; the number of beetles surviving; the number of living and dead larvae; the increase in the number of larvae in first instars, I reached the following conclusions: extending over a period of fifty days in a mean temperature of 65°F. adult beetles and larvae in the last instars seem to be but slightly affected by an atmospheric humidity ranging from approximately 1% to 100%. As the humidity increases up to 75% the number of dead beetles in the jars increase; from the fact that I found as many dead beetles in the jar having 100% as in the jar having 45% this data does not seem to be conclusive and further experimentation is necessary to test out this discrepancy. A very marked increase in the number of larvae of the first instars accompanies an increase in humidity, the actual numbers in increase being from 58 in atmosphere of 1% humidity to 412 in a humidity of approximately 100%. The optimum humidity for young larvae of *Echocerus cornutus* is approximately 100% but with this humidity, in the course of thirty days, a fungus appears which no doubt would, in a very short time be destructive to all beetles. In the light of this then it is quite possible that the most favorable condition for the development of this beetle would be in an atmosphere of a humidity of somewhere between 75% and 85%. In this experiment no account was taken of changes of temperature and light as I considered that for practical purposes perfect control of these factors was unnecessary.

It is unfortunate that the test could not be extended over a longer period of time,—I intend, however, at a very early date, to repeat this test, extending it over a much longer period of time.

METHODS OF CONTROL. The chief means of control of *Echocerus cornutus* are the use, in Germany, of *Bacillus-thuringensis*; in England, hermetical sealing; in Canada, of chloropicrin, and in the United States and elsewhere, the elimination of breeding places, fumigation with carbon bisulphide and hydrocyanic acid gas and the heating of mills to a temperature of 120°–130°F. for a period of twelve hours.

SIMPLE METHODS OF REARING WIREWORMS (ELATERIDAE)

By M. C. Lane, *Junior Entomologist, Cereal and Forage Insect Investigations U. S. Department of Agriculture*

Abstract

It is the purpose of this paper to record a few successful and simple methods of rearing one of the most difficult groups of insects with which the economic entomologist has to deal, namely wireworms of the family Elateridae. The writer's studies and experiences have been confined mostly to two species, *Ludius noxius* Hyslop and *Pheletes occidentalis* Candeze of Washington State, but since these two species exist under a great variety of conditions from very dry to very wet, it is felt that the suggestions regarding methods and rearing here given can be adapted for other species in other sections.

In rearing subterranean larvae, such as wireworms it is almost a necessity to have some sort of an underground or cellar laboratory. Of course an underground chamber fitted with extensive temperature and humidity control apparatus would be ideal, where the expense could be afforded at some permanent research laboratory. But for all practical and general purposes a house or outside underground root cellar will answer very well. The latter is ideal in situations where there is good drainage and may be constructed with side walls of boards, a dirt floor, double doors, and a roof covered with sods. If shelves and a table with a light are installed, the different stages of the wireworms can be handled without fear of injuring them from lack of humidity or through extremes of temperature. Humidity and temperature usually remain about the same as are normally found from four to ten inches deep in the soil, varying about the same or very little from day to day. In the case of a laboratory situated in a house cellar made of cement, it would probably take some practice to maintain the proper amount of humidity and temperature. A separate small room in the north corner of a large cellar would seem to offer the best solution.

Adult elateridae can usually be procured in the fields by sweeping in the early spring, especially along the fence rows and ditch banks. It usually takes several consecutive warm days with temperature over 70 degrees F. to bring the adults from their winter cells, but when the weather once becomes permanently warm the adults will emerge and fly actively on sunny calm days for a week or two, after which the emergence is over till another year.

The obscure habits of the female adult elaterid and her apparent inaptitude to fly and expose herself as freely as the male, makes the procuring of sufficient females for rearing purposes difficult. In order to make sure of a supply of female adults, it was found necessary to rear

them from larvae. This should be done the previous spring by collecting as many full grown larvae as possible and confining them in soil cages. A simple and very effective soil cage for rearing any stage of the larvae can be made out of galvanized sheet iron, of guages ranging from 20 to 30. These are best made in the form a cylinder, by rolling two pieces of iron of the same size to a half circle and joining them together with baling wire, a fold being provided on one vertical edge of each half to receive the straight edge of the opposite half snugly. These cylinders without top or bottom can be made in any desired diameter and depth, but two pieces of galvanized iron 23 x 18 inches in the flat, when rolled and one edge of each folded over and back once using up 1½ inches of iron, will make when joined together, a cylinder about 12 inches in diameter and 18 inches deep. This is set into the ground at a depth of at least 15 inches and filled with soil. The soil within the cylinder should be tamped as hard as normal soil in field, or preferably the cages should be placed in the ground during the previous fall, in order that the winter rains and snows may settle the soil normally. When the soil is left too loose, the wireworms are likely to burrow deeply and possibly escape from under the lower end of the cylinder. The described size of cylinder accommodates ten or more larvae easily and is not too heavy for one man to lift from the ground and examine. When ready for examination this cylinder should be dug and laid horizontally on a canvas, in which position the upper half can be removed and the soil examined carefully by screening or otherwise.

Full grown larvae if placed in these cylinders before June first will pupate normally and thus with a series of cylinders the pupal stage or period can be determined accurately. If adults alone are desired it is best to leave the cylinders undisturbed until the following spring, when they can be removed before regular emergence date and adults recovered in perfect condition. Adults when taken from the soil in the fall and kept over winter in small tins usually have a high mortality from molds and bacteria.

Adults procured for rearing should be kept separate according to sexes till ready for mating. Sexes of the economic species of Elateridae can usually be determined by the more robust form of the female and her shorter antennae with joints slightly stouter. The male is usually slender, with antennae reaching nearly to the base of the thorax and joints flattened laterally.

Mating of adults is best done on warm sunny days, inside or out of the wind. Containers deep enough so that the beetles cannot fly or climb

out easily can be used, and the adults placed in these on a little damp soil, either in pairs or in numbers. As soon as a pair of adults are noticed in copulation, they can be removed in situ and placed in salve tins.

For all rearing purposes with wireworms the ordinary salve tin, either with plain or paper label lids, of the two ounce size seem to fulfill all the requirements. Smaller sizes will not contain enough soil and dry out too easily, while larger sizes are unnecessary, unless one wishes them for field collecting.

In order to save time in picking eggs from the soil of the salve tins after oviposition, the soil should be sifted through fine brass screen of mesh sufficiently small to retain the eggs of the species under study. A common milk screen of 40 mesh to the inch is about right for most of our economic species. Small deep round cake pans about 10 inches in diameter with false bottoms can be purchased cheaply and the screen easily soldered to the bottom. Soil should be as damp as will sift through this screen. After a female has oviposited a lot of eggs in this tin of fine soil, the contents can be sifted again and all the eggs retained free from soil.

Eggs can easily be counted by placing them in a shallow coffee can cover painted a dull black and using a tally counter operated by foot power. As soon as counted, the eggs should be placed on sterile watch glasses, either with or without filter paper, and the watch glasses placed in sterile petri dishes containing a little water. This provides a moist chamber without bringing an excess of moisture in contact with the eggs and when kept in a humid cellar will hatch the eggs normally. Eggs can also be left in the fine soil in salve tins until all the larvae have emerged, when it will be easy to sift out the newly hatched larvae. Care is necessary in the egg stage to prevent molds from entering the dishes and killing the eggs. Since the mold often enters the dishes with a slight amount of soil that sticks to the eggs, it is almost impossible to prevent some of the eggs from being lost in this way. The ordinary china marking grease pencils are very useful in marking on the glass of the dishes and also for marking the salve tins.

When the larvae begin to emerge from the eggs they should be removed daily from the dishes to finely sifted soil in the salve tins again, with their preferred food. Sprouting wheat with its fine rootlets serves well for those species destructive to grains. Sliced potatoes or sugar beets can be used for other species. The soil in these tins should be changed as often as necessary to renew the food and prevent them from drying out. By using the finely sifted soil again, the larvae can easily be

found by resifting. Several ways of rearing the tiny larvae have been tried in order to obtain the molted skins, but no very satisfactory method has been found. The best method seems to be in placing the larvae on sliced roots in petri dishes between layers of dark colored blotting paper, but it is very hard to keep the dishes clean and at the right degree of moisture.

After the larvae attain a size of 8 to 10 millimeters they can be placed in outdoor cylinders. Cylinders prepared for the reception of these small larvae should be filled with soil sifted through a 20 mesh screen to keep out strays and still be able to retain the larvae under observation when necessary to resift.

Adults after mating can also be introduced directly to the outdoor cylinders, by using a screen top of ordinary window screen. The screen should be cut to fit snugly within the cylinder and be as high as necessary to allow for plant growth. This screen cylinder top can be sewed with copper wire and if the selvage is allowed to come at the top, be made beetle tight by bending inwards in three places and sewing the selvage together where it meets. One or more mated female adults introduced in one of these cylinders will burrow down and deposit their eggs normally, so that on subsequent examination the depth of oviposition can be determined. These screen tops can also be used to determine spring emergence dates of adults.

For outdoor life history and control work with wireworms where it is desired to eliminate as many unknown factors as possible, a larger cage can be used. This cage can best be made in the form of a rectangular box without a bottom, 10 feet long by 4 feet 4 inches wide, containing approximately one thousandth of an acre of soil area. This cage should be sunk in the ground to a depth of at least 15 inches. Either grooved boards or galvanized sheet iron can be used in making this cage.

When a known number of larvae are introduced to this cage accurate checks can be made on their feeding habits and control experiments be carried on over several years without fear of the larvae escaping. A rectangular screen top may be made to fit this cage, allowing the adults to emerge normally and their habits to be studied. A series of these one thousandth acre cages can be arranged, so that a variety of habitats can be provided and all the different broods of the wireworms kept under experimental control.

Conclusion

The writer has used with success all the different methods and cages herein described and believes that with proper adaptations most of them

can be used successfully in other regions and with other species. It is hoped that this paper will answer satisfactorily in part the many inquiries received during the last year or two from economic entomologists regarding the methods of rearing wireworms.

The meeting was adjourned to meet next year with the Pacific Division, American Association for the Advancement of Science.

MIGRATION—AN IMPORTANT HABIT OF THE EUROPEAN CORN BORER

By Geo. W. Barber, *Cereal and Forage Crop Insect Investigations, Bureau of Entomology, United States Department of Agriculture*

Abstract

This paper deals with the migratory habits of the European corn borer, *Pyrausta nubilalis* Hubn., in the heavily infested area of Massachusetts. Evidence obtained from study of the insect in the field is presented, showing that the larvae sometimes migrate in large numbers, particularly from over-populated corn stalks. It is shown that this movement is greatest on the warm nights of late summer. Over-wintering of larvae in locations, other than the host plant, is discussed.

This information has a distinct and important bearing on the field measures used to reduce the number of this insect. If larvae migrate in appreciable numbers from host plants before such infested plants are destroyed, and find hiding places where they successfully pass the winter, the effectiveness of such control measures may be greatly reduced. Knowledge of the hiding places of migrating larvae is important so that more effective control measures may be found.

The migratory habit of the European corn borer (*Pyrausta nubilalis* Hübn.) is important, becoming very important when the insect is particularly abundant. In such cases, should a large number of individuals leave the food plant in which they had been feeding to seek other or fresher food, to seek more advantageous winter quarters, or because of an over-population of larvae for which the food is inadequate, the effectiveness of control measures such as the destruction of crop remnants may be considerably reduced. If these migrating larvae find concealment in unexpected or unusual places a sufficient number may survive to produce a destructive infestation the following year, notwithstanding that the "clean up" campaign has been waged with apparent thoroughness and care.

During 1922 in eastern Massachusetts an excellent opportunity existed for the study of this important subject. During August and September of that year when larvae of the second generation were present in the field, individuals were more abundant than at any

previous time in the history of this insect in the United States. In some fields the infestation was at the rate of from one and a half to two millions of borers per acre of sweet corn. Such great abundance of the insect caused, in some instances, an overpopulation of borers or, there were present in some fields a larger number of larvae than there was food present to satisfy.

Migrating larvae were then very numerous and during warm nights on visiting such a corn field thousands of larvae might be found moving about. With the coming of dawn, however, all were again invisible having entered the corn stalks from which they had issued under cover of darkness, bored into fresh food if such had been found, or they had found places in which to hide during the day.

To obtain information as to the extent of this migratory habit a series of 47 traps were placed in an experimental plot of about 1⅓ acres where corn of different types, flowers and vegetables were being grown and where larvae of the European corn borer were very numerous. The trap used consisted of a board 3 feet long by 4 inches wide, one long edge of which was sharpened so as to set firmly upright in the soil. A detachable cover was placed on top and extended about an inch on either side. Just under this cover strips of corrugated card board an inch wide were tacked to the side of the upright board. Migrating larvae finding this trap across their path and being unable to pass beneath the trap because it set in the soil had either to go around it or pass over it. If they chose the latter alternative they would find the corrugated card board and this being an ideal hiding place, they would remain. These traps were examined each morning where possible. In figure 5 the number of larvae found in all these traps each morning is shown graphically.

These traps were in operation from September 16 to October 14. During that time 1904 larvae were recovered from them, the greatest number of larvae on any one day being 186 and the greatest number from one trap for one day 23. The greatest number taken from one trap for the whole period was 223. The larvae caught in these traps must have been a very small per cent of the total number of larvae that were migrating but this information indicates that migration was very extensive.

The migration as indicated from a study of the records of these traps was greatest from corn which was overpopulated to flowers and vegetables nearby but the movement was very general over all the cultivated area.

The northeast side of this cultivated area was bordered by a row of willow trees some 20 feet from the edge of cultivation, the intervening space being in grass. Along this edge (358 feet) three traps were placed about 15 feet from the edge of cultivation. In these three traps a total of 109 larvae were recovered during the whole period of observation indicated above, the greatest number in the three traps for any one night being 29 and the greatest number in one trap one night being 19. The 9 feet covered by these traps is but a very small fraction of the total distance along this side of the field, so that from these indications it may be safe to say that a considerable number of larvae moved out of the cultivated area and sought some location other than the food plant in which to spend the winter.

In overwintering cages placed for the purpose of observing whether the larvae of this insect were able to successfully pass the winter in sod, 13 pupal cases from which adults had issued in the spring were found in rolled up maple and elm leaves. A total of 50 larvae were introduced into these cages in the fall. This is a significant point in connection with the extensive migration described above.

About a quarter of a mile from the plot previously described there is a small area of bog which in the summer of 1922 had grown up to a nearly pure stand of Polygonum sp. and these plants, common hosts of the insect, were well infested with larvae. Along one side of this bog on rising ground there is a row of old apple trees.

Towards the middle of September of this year it was observed that windfall apples under these trees were riddled by larvae of the European corn borer. Investigation and recovery by the use of migration traps showed that the larvae were migrating in great numbers from the polygonum and were moving towards higher ground either in search of fresh food or of hibernating quarters. The condition of the windfall apples showed that they had satisfied the first mentioned desire while on examination of the trees showed that some of the larvae at least had taken refuge there. Under the rough bark, in cells not unlike those in which larvae of the codling moth spend the winter, the corn borer larvae were found in some numbers and others had penetrated the rotten wood of stumps that remained after limbs had been removed. Subsequent examinations through the winter and following spring showed that not only did larvae spend the winter under the bark but that they pupated and adults emerged, the live pupae and empty pupal cases from which adults had issued being recovered from cells under the bark. From previous experiments it is known that the burrowing of larvae into

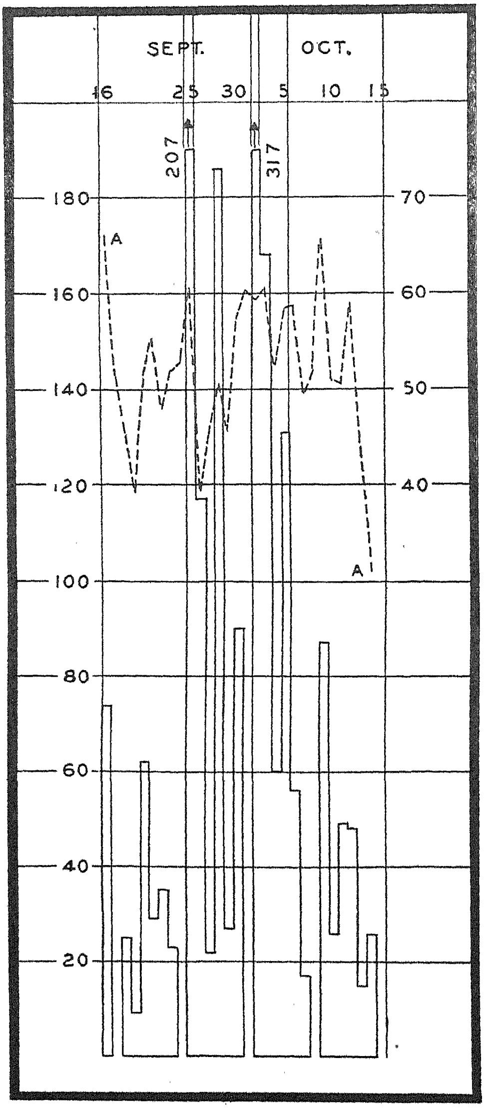

Fig. 15.—Comparison of the number of migrating larvae recovered daily in the fall of 1922 with the mean night temperatures. The graded scale to the left indicates number of larvæ and applies to the blocked-in area. The scale to the right applies to the mean night temperatures shown by the broken line AA. Blank spaces in the record of number of larvae mean that traps were not examined on those days, the record for the day immediately following showing the migration of two nights.

willow trees. Of the total number of larvae (504) found in these traps over the whole period of spring observation, 414 were taken from traps placed between the piles of corn stalks and the row of trees. For some unknown reason in this instance as well as in the observations made in the fall, it seemed that the migration of larvae toward the northeast was much greater than in other directions. However toward that direction there was a considerable accumulation of fallen leaves and other places suitable for hiding, including a few weeds. These remarks apply only to larvae that left the cultivated area. Those moving about in the cultivated area during the fall seemed to move toward fresh food as a usual thing.

Within piled up corn stalks there is also an interesting movement of larvae, those in the centre of the pile where the stalks remain wet, deserting such stalks and moving to the outer dry stalks where conditions for pupation and emergence are much more favorable and where the direct benefit of the sun is felt much sooner than would be the case in the centre of such piles. On May 12, 1921 an examination was made of such a pile of corn stalks to obtain information on this point. In 46 stalks partly wet and partly dry—stalks that extended from the centre of the pile to the outside—there were found:

	Wet portion	Dry portion
Live larvae	3	173
Dead larvae	6	16
Pupae	0	2

In 50 dry stalks from the outside of the pile there were found: Live larvae, 301; Dead larvae, 26; Pupae, 46.

In 50 wet stalks from the centre of the pile there were found: Live larvae, 2; Dead larvae, 4.

In the above instance stalks were on an average equally infested in the fall and larvae remained distributed through the whole pile until it became warm enough for them to become active in the spring.

This movement of larvae in the spring is different from the fall migration in that in the spring the larvae apparently seek only favorable places in which to transform while in the fall they seek not only more likely localities in which to spend the winter but also in many cases fresh food to enable them to complete growth.

We have previously stated that on warm nights of late summer and early fall migrating larvae are to be found very active while such activity ceases with the coming of day when the larvae seek shelter during the hours of daylight. In fact larvae outside of their burrows are very in-

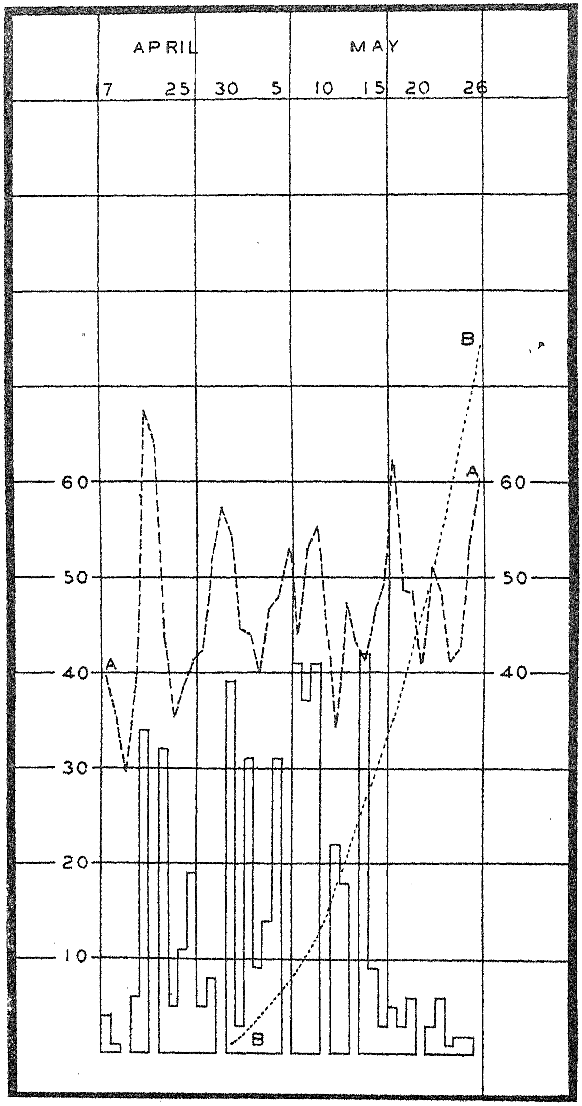

Fig. 16.—Comparison of the number of migrating larvae recovered daily in the spring of 1923 with the mean night temperatures. The scale to the left indicates number of larvae which is shown by the blocked-in area. The scale to the right applies to the mean night temperatures shown by the broken line AA. Progress of pupation is shown by the dotted line BB. Blank spaces in the records of number of larvae means that traps were not examined on those days, the record for the day immediately following showing the migration of two nights.

frequently seen during the day. In figures 15 and 16 the mean night temperatures are compared with the larval migration as indicated from daily recoveries from migration traps. Night temperatures are used in preference to means for 24 hour days because it is the temperature of the hours from dusk to dawn that influences directly the activity of the larvae, since it is then that the larval migration takes place. The mean night temperature was obtained by averaging readings of 8 P. M., 10 P. M., 12 P. M., 2 A. M. and 4 A. M. In the case of the spring migration (Fig. 16), the progress of pupation is shown and it is interesting to note that some larvae continue to migrate after pupation is well advanced. A study of these figures will show that usually the extent of the migration on any night bears a distinct relation to the mean night temperature, becoming most heavy as a rule when the mean night temperature approaches or exceeds 60 degrees F.

Conclusions

Migration of larvae of the European corn borer may in times of great abundance of the insect, be extensive, the larvae moving in the fall to seek fresh food and to locate desirable winter quarters and in the spring to find favorable places for transformation to adults.

Such migrating larvae may successfully pass the winter in rolled up leaves, under the bark of trees, in burrows in wood, or in plants not favored as food plants and may in such locations successfully transform to adults.

When migration to such locations is at all extensive and when it takes place in the fall before crop remnants are destroyed by burning or other means, the effectiveness of such control measures is considerably reduced since a sufficient number of larvae may survive to cause a destructive infestation the following year.

THE BIOLOGY OF ANOMALA KANSANA (SCARABAEIDAE, COLEOP.)

By Wm. P. Hayes and J. W. McColloch,
Kansas Agricultural Experiment Station

Abstract

This paper discusses the economic importance of this recently described species. Its life history, with the length of the various developmental stages, is considered. It is found to have a one-year life cycle. The adults appear in June and July. Eggs are laid in the soil and the larvæ live over winter. Pupation occurs in late May, June, and early July.

INTRODUCTION*

During the course of studies on the white grubs and May beetles of Kansas, a new and important species of the genus *Anomala* has been under observation for the past few years. Considerable data on its life history having accumulated, an account of these are here set forth.

The species has been recently described (Hayes and McColloch, 1924)[1] as *Anomala kansana*. The writers are indebted to Mr. Warren Knaus for calling their attention to the fact that this species was undescribed.

ECONOMIC IMPORTANCE

From its relative abundance and somewhat general feeding habits, this species can be regarded as of economic importance and one which

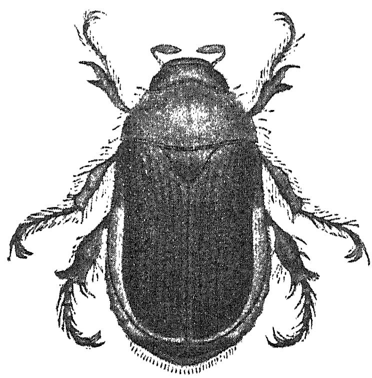

Fig. 17.—*Anomala kansana* adult, enlarged (Drawing by S. Fred Prince).

may prove a troublesome pest. The adult feeding habits are crepuscular and quite varied, having been found on strawberry leaves, sorghums, corn, wheat heads and wheat in the shock, sweet clover, sumac, rye, dogwood, pasture grass, lamb's quarter, smartweed and horse thistle.

The larvæ likewise are quite general feeders and have been collected in a number of different situations, such as under logs, on sand dunes, in corn-fields, under rocks in woodland, in wheatfields, gardens, blue-grass sod, alfalfa land, oat-stubble, potato fields and roots of Sudan grass. The determination of the specific identity of grubs found in these situa-

*Contribution No. 328 from the Entomological Laboratory, Kansas State Agricultural College. This paper embodies some of the results obtained in project No. 100 of the Kansas Agricultural Experiment Station.

[1]Hayes, W. P., and McColloch, J. W., A New Species of *Anomala*. Ent. News 35:138–140, 1924.

tions was made by rearing them to maturity. It is of interest to note that of approximately 200 grubs collected and reared, 190, or 95 per cent, were found in wheatfields. This large proportion may be partly due to the ease with which collections may be made behind the plow. It is evident from the general feeding habits and the preponderance of individuals in wheat land that the species is capable of doing some damage, especially to wheat.

Life History

ADULT. The beetles are nocturnal in habits, appearing at dusk to feed, after which they are readily attracted to lights. The beetle (fig. 17) is dark brown to piceous in color, with lateral margins flavo-testaceous; ventrally it is fusco-testaceous to rufo-testaceous with a faint, greenish, metallic lustre; the legs are rufo-testaceous and in size the species varies from 11 to 12.5 mm. long, and 5 to 6.75 mm. wide.

The insects are relatively abundant every year. In this study they were found more frequently at lights in 1921 and 1922, but after their food habits were discovered in 1923, they were found more abundantly on food plants. The total numbers collected and the numbers reared from collected grubs and from eggs hatched in the field laboratory are shown in Table I.

TABLE I—SHOWING THE RELATIVE ABUNDANCE OF ANOMALA KANSANA

Source of collections	1921	1922	1923	Total
At lights	16	82	32	130
On food plants	1		373	374
Miscellaneous	1		2	3
Collected grubs	157*	9	43	209
From eggs		16		16
Total	175	107	450	732

*Includes three specimens reared in 1919.

As shown by Table I, sixteen individuals were raised through all their stages from egg to adult. It may also be noted that of several hundred grubs collected in the fields, 209 were reared to adult. The length of the various stages as discussed in this paper are based on these numbers.

T his species is attracted to electric lights during June and July. In 1921, their first appearance at lights was June 13 and the last June 29. In 1922, they were present at lights from June 9 to July 12, and in 1923 from June 23 to July 16. These dates correspond closely to the entire period of flight for the three seasons, except that in 1921 they were

found on food plants one day earlier (June 12) than at lights and in 1923 they were found three days earlier (June 20) on sorghum and wheat plants. The length of the flight period in 1921 was shorter than the other two flights extending over a period of only 17 days. In 1922, the flight period was 33 days and in 1923, 26 days, making an average flight period for the three years of approximately 25 days.

The adults apparently exhibit no strong preference for any certain type of soil. As previously stated, most of the grubs have been collected in wheat fields, but they have also been found in corn land, both on upland and lowland, in sandy dunes along the Kansas river, in sod land, and in rocky woodland.

Mating was observed in the laboratory only, when it was noted to occur on the surface of the soil in rearing cages in the late afternoon. In 1921, the first eggs laid in laboratory cages were found on June 15, only three days after the first appearance of flight was noted. In 1922, the first eggs were found June 14, five days after appearing at lights and in 1923 the first eggs were observed June 26, being 6 days from the time they were first noted on food plants. From this it can be conjectured that the pre-oviposition period is relatively short or that mating may occur in the soil before emergence, which fact seems doubtful, notwithstanding the fact that the Scarabæid genera *Ligyrus* and *Ligyrodes* mate in the soil. Females were observed mating after oviposition had occurred.

Egg. The eggs are laid in the soil, and, like other Scarabæid eggs, increase somewhat in size after being deposited. The number of eggs laid by a female was not noted, but one dissected female was observed to contain 26 full sized eggs. When freshly laid, the eggs are about one millimeter wide and 2.25 millimeters long. They are milky white in color, elongate oval in shape, changing to a more spherical shape as development proceeds.

Egg laying began in 1921 on June 15; in 1922 on June 14, and in 1923 on June 26. The length of the egg stage varied from nine to 19 days with quite different averages for the four seasons observed. The maximum, minimum and average periods of egg development for the years 1920 to 1923 are shown in Table II.

Larva. The larvæ of *Anomala kansana* closely resemble the larvæ of other species of this genus and have much in common with other grubs of the family Scarabæidæ. Upon hatching, the young larvæ are about twice the length of the eggs from which they emerge and when fully grown are about 24 millimeters long and seven millimeters wide

TABLE II—THE LENGTH OF THE EGG STAGE OF ANOMALA KANSANA

Year	Number of eggs	Maximum days	Minimum days	Average days
1920	5	15	13	14.6
1921	486	19	9	12.6
1922	40	16	9	13.9
1923	101	17	9	11.9
Total extremes and average	632	19	9	12.2

behind the head. The head is tan colored and the body creamy-white in color.

The larvæ began hatching in 1921 on June 27; in 1922 on June 24, and in 1923 on July 9. The first molt occurred from 12 to 36 days after hatching with an average period for the first instar of 20.5 days for 69 cases observed. The second molt occurred the same season from four to as many as 52 days after the first molt. For 46 molts observed, the average period of the second instar was 16.8 days. The winter is passed in the third larval instar, which varied from 285 to 311 days, with an average of 301.6 days for 21 cases. Prepupation begins in late May and early June, having been noted to occur as early as May 28 and as late, in an extreme case, as July 1. The prepupal stage for 22 grubs reared from egg to pupation varied from three to seven days with an average of 4.1 days. For 83 grubs reared from collections made in the field, the average was 4.02 days, with extremes of two to 16 days. The average for the two groups was 4.06 days.

The total length of the larval stage, including the prepupal stage, was noted for 23 individuals and found to average 336.3 days, with a minimum period of 322 days and a maximum period of 345 days. The length of the larval stage from hatching to prepupation was noted in 20 instances where extremes of 280 to 308 days were observed, with an average of 298.3 days. These data are summarized in Table III.

TABLE III—THE LENGTH OF THE LARVAL STAGE OF ANOMALA KANSANA

Period	Number of individuals	Maximum days	Minimum days	Average days
Hatching to first molt	69	36	12	20.5
First molt to second	46	53	4	16.8
Second molt to prepupa	20	308	280	298.3
Second molt to pupa	21	311	285	301.6
Prepupa to pupa	105	16	2	4.06
Total larval stage	23	345	322	336.3

PUPA. The pupa, when freshly transformed, is creamy white in color. As development proceeds, the darker colors of the adult insect are assumed. Pupation occurs during late May, June and early July, having been noted as early as May 30, and as late as July 11. The length of the pupal stage varies from eight to 20 days. In all, 212 pupæ were observed for the length of this stage. Among grubs reared from eggs, the pupal stage averaged 10 days for 16 pupæ. Grubs collected in the field averaged 12.5 days in 1922 for 153 instances, and in 1923, 43 pupæ had an average period of 9.9 days. These data are summarized in Table IV.

TABLE IV—THE LENGTH OF THE PUPAL STAGE OF ANOMALA KANSANA

	Year	Number reared	Maximum days	Minimum days	Average days
Collected grubs	1922	153	20	9	12.5
Collected grubs	1923	43	17	8	9.9
Reared grubs	1922	16	12	8	10.

SUMMARY

This new species of the genus *Anomala*, because of its widely varying feeding habits and rather general occurrence in the region in which it is found, bids fair to become of considerable economic importance. The beetles feed at dusk and fly to lights. Eggs are laid in the soil in June and July and require an average of 12.2 days for hatching. The larvæ live in the soil over winter. Molting occurs twice. The first molt occurs on the average 20.5 days after hatching and the second molt, an average of 16.8 days after the first molt. The total larval stage varied from 322 to 345 days, with an average of 336.3 days. From this should be subtracted an average of 4.06 days for the prepupal stage. The pupal condition lasts from 8 to 20 days. Pupation occurs in late May, June and early July. After transforming to the adult stage, the beetles soon appear above soil to feed and reproduce.

THE CORRECT NAMES OF THE LEAFHOPPERS INFESTING THE APPLE AND POTATO

By E. D. BALL

ABSTRACT

There has been much confusion and misunderstanding with respect to the scientific and common names to be applied to the three species of leafhopper infesting the apple,

namely *Typhlocyba rosae*, *Empoasca maligna* and *E. fabae*. A key to the insects and another to the injury will assist in determination. The earliest species described by Harris and Walsh are for the first time considered and their scientific names applied. This should give a stable scientific nomenclature and if the common names recommended are adopted, confusion can be avoided in the future.

There has been much confusion and uncertainty in regard to the number of species of leafhoppers infesting the apple as well as to the scientific and common names that should be applied. The fact that two of these species also seriously injure other economic plants has served to complicate the situation. Sufficient study has now been made of the subject in different parts of the United States to warrant a fairly definite statement that three species of the *Eupteryginae* (*Typhlocybinae*) and only three are commonly found on apple trees. Parrott (1909) was the first to point this out for New York conditions. Lathrop (1918) working at Geneva differentiated the nymphs and worked out the life histories. Later studies by Childs (1918), the writer (1918), Fenton and Hartzell, (1923) Ackerman, and others, have confirmed these results for the different apple-growing regions of the United States.

These three leafhoppers can be readily separated by the following key.—

A. Nymphs white, adults white or pale golden; two generations of nymphs, the first one early. The Rose Leafhopper (*Typhlocyba rosae* Linn.)

AA. Nymphs and adults green.

- B. Adults stout, deep green, with a blunt head, a single generation of nymphs appearing early. The Apple Leafhopper (*Empoasca maligna* Walsh)
- BB. Adults slender, fragile, pale green, with an angled head, two generations of nymphs, the first one appearing late. The Potato Leafhopper (*Empoasca fabae* Harr.)

These leafhoppers may also be separated by the appearance of the injury they cause.

A. White spotting on the upper surface of the *older* leaves, especially in the lower part of the crown of bearing trees, leaves remain flat, (nymphs found on under surface only, eggs winter in bark.)

- B. Nymphs and adults white; occur throughout the season on rose and apple. The Rose Leafhopper.
- BB. Nymphs and adults green, nymphs early only, adults later and confined to apple. The Apple Leafhopper.

AA. Curling and distortion of young leaves of watersprouts, tips or nursery stock; tips and margins of badly affected leaves turn brown, no white spotting. On potato, apple, beans, raspberries, gladioli, etc. Adults hibernate and lay eggs through a long period. The Potato Leafhopper.

No serious attempt has been made previous to this time to accurately determine or place the earlier described species of *Empoasca* and *Typhlocyba* of Harris and Walsh and thus place our nomenclature of these

economic forms on a stable basis. Woodworth (1888–89) published a preliminary review of the genera but did not attempt to define the species. Gillette (1898) in his "American Leaf-Hoppers of the Subfamily Typhlocybinae" ignored *fabae* of Harris, the genus *Chloroneura* of Walsh, and did not place *C. maligna* or *C. malifica*, the two injurious species from apple which Walsh described under this genus. Hartzell (1924) in his "The Genus *Empoasca* in North America" followed Gillette in the use of color characters for the separation of species and also failed to recognize any of the earlier described injurious species.

A careful study of some of the more common species of *Empoasca* has shown that many of them are widely variable in color characters, ranging all the way from uniform green or yellowish to definitely lined, spotted, banded, or highly ornamented forms. It is therefore probable that when the entire genus is carefully studied there will be other synonyms added to the lists below. These will not, however, affect the name of the species as in this study the older names have all been considered.

In this connection it is well to remember that Harris, LeBaron, Walsh, and Forbes were only interested in discussing species sufficiently abundant to be injurious to crops. Walsh described other species because as he states, "Of these six divisions, the four last all comprise species of about an eighth of an inch in length, and of a uniform pale green or yellowish color, with scarcely any markings. These I propose to describe, as they are liable to be confounded with the two foes of the apple and pear." Naturally these must have been representatives of the more common and widely distributed species in the region. A detailed study of his species bears out this conclusion.

The Rose Leafhopper (*Typhlocyba rosae* Linn.)

This species is white with a golden tinge and is considerably larger than *fabae*. The nymphs are white instead of green as in the two following species. It has two generations annually. The winter is passed as an egg under the bark, usually of a rose bush, the first generation nymphs then live on the underside of the rose leaves, their punctures whitening the upper surface. The adults fly to the apples and the second generation follows *unicolor* in whitening the older apple leaves and doing serious damage. This is in nature a rose pest and both generations may remain on that plant. On the other hand, in seasons of unusual abundance, the overwintering eggs may be laid on the apple. This is the common pest of apples in the northwestern states and is occasionally seriously injurious in

certain localities throughout the apple-growing region. Although reported as *mali*, this is the species that was notably injurious in New England localities in the early season of 1924. It has always been called the rose leafhopper and that name should be continued. It is especially injurious to apples in regions where roses abound. The sweetbriar of the northwest is a constant breeding ground for this species.

The Apple Leafhopper (*Empoasca maligna* Walsh)

Chloroneura maligna Walsh. Prairie Farmer, pp. 147–149, Sept. 6, 1862. Reprint Proc. Bost. Soc., Nat. Hist. Vol. 9, p. 317, 1864.

Empoasca unicolor Gill. Proc. U. S. Nat. Mus., Vol. XX, p. 731, 1898. Hartzell: Proc. Ia. Acad. Sci., Vol. 30, p. 100, 1924.

This species is a beautiful golden green in color, with a bluntly rounding head and is larger, and much less fragile than *fabae*. The nymphs are leaf green. It has a single generation annually and spends its whole life on the apple. The winter is passed in the egg stage under the bark of the twigs. The nymphs appear late in the spring after the apple leaves are well grown; they feed on the under side of the mature leaves and cause a whitening of the upper surface but no rolling or distortion. The adults remain on the trees through the remainder of the summer, laying eggs to pass the following winter. This species is distributed from the Rocky Mountains to the Atlantic and in company with the preceding is responsible for all of the injury to mature apple foliage usually manifested by the whitening of the upper surface of the leaves.

Walsh described this species as the malignant leafhopper because this and the preceding species were supposed to be the cause of fire blight on the apple and pear, thus definitely placing this as one of the two apple-infesting species. With this in mind his description and figure (of the head) are so accurate that there can be no mistake. He says "Differs from the above *malifica* (*fabae*) as follows:—"The color is deeper, the head is almost transverse, its anterior edge forming about half a quadrant; the elytra are subopaque and deeply tinged with green, and the anal vein attains the cross-vein nearly." The figure of the head shows the short blunt head of this species which would alone separate it at once from *fabae*, the other apple species, but when he describes the deeper color, so deep that the elytra are "subopaque" instead of "subhyaline" as in *malefica* (*fabae*), he gives the most distinctive character of *maligna* and one that will definitely distinguish it from any other species found on the apple tree.

This is *the* apple leafhopper; it spends its whole life on the tree and

frequently does serious injury. It should undoubtedly be called the apple leafhopper and the other species named for their preferred hosts.

THE POTATO LEAFHOPPER (*Empoasca fabae* Harr.)

Tettigonia fabae Harr. Ins. Inj. to Veg., p. 186, 1841.
Tettigonia mali Le B. Prairie Farmer, XIII, p. 330, 1853.
Empoasca viridescens Walsh. Prairie Farmer, Sept. 6, 1862. Rept. Bost. Soc. Nat. Hist., IX, p. 316, 1864.
Empoasca consobrina Walsh. Ditto.
Chloroneura malefica Walsh. Prairie Farmer, Sept. 6, 1862. Rept. Bost. Soc. Nat. Hist., IX, p. 317, 1864.
Typhlocyba photophila Berg. Hemip. Argent., p. 273, 1879. (Vide Gill.)
Empoa albopicta Forbes. 13 Rept. Ill. St. Ent., p. 181, pl. XIV, 1883.

This is a slender fragile pale green species with an angled head. The nymphs are green. Harris described this species as injurious to beans. Most of the early literature speaks of it as an apple or nursery stock pest. It is primarily a potato pest, its attack producing the hopperburn (formerly included under tipburn), that has been so injurious in northern and eastern United States in recent years. In periods of abundance it also attacks watersprouts and nursery stock of apple, succulent growth of raspberries, boxelders, gladioli, and occasionally other trees and shrubs and produces similar burning. When potato fields have been destroyed it may migrate to and seriously injure beans. The mature adults, especially at the mating season, usually exhibit white spotting on the vertex and face, a row of about eight spots on the front of the pronotum and a broad "H" on the scutellum. These markings are not on the chitin but in the tissues beneath and they largely disappear in the dried specimens. No other species occurring in this region could fit Harris' description, particularly "slender, delicate pale green elytra transparent," infests beans in July, especially in dry years.

When the writer found the potato leafhopper (then called *mali*) migrating from potato fields that had been destroyed into adjacent bean fields and destroying them, he became curious as to the identity of Harris' *fabae* and took the first opportunity to examine the types[1] in the Harris collection.

The types were found in a fine state of preservation for so fragile an insect. They bear the label "No. 253 on corn and beans, August 15, 1838." There were originally three specimens on one card of which

[1]The Harris collection is well cared for in the Boston Museum of Natural History and the writer wishes to express to Dr. C. W. Johnson his appreciation of the privilege of examining these and other types.

there remains one entire insect and one with the head gone. Three elytra show the triangular apical cell. The under wings show the single apical cell with a marginal nervure. One specimen shows the forked white marking on pronotum, so distinctive. In every way they are characteristic of the species. A specimen pinned along side marked "Fitch 196" shows all the white markings as commonly illustrated.

LeBaron (1853) found examples of this species damaging the young leaves of the apple and especially young nursery stock and noted that they crumble and roll the young leaves. These examples had all the white markings distinct and not recognizing Harris' species, he described them as *mali*.

Walsh (1862) studied the species of leafhoppers injurious to the apple and pear and described the genera *Empoasca* and *Chloroneura*, the former with a triangular apical cell in the elytra and the latter with a quadrangular one. As this character is widely variable in the different examples of the same species and often on the two elytra of the same example, the genus *Chloroneura* becomes a synonym of *Empoasca*.

Walsh described three new species under each genus. Of these *Empoasca obtusa* Walsh and *Chloroneura abnormis* (= *Dikraneura abnormis* Walsh) have been generally and apparently correctly placed. In republishing this paper in the Proceedings of the Boston Society of Natural History the next year Walsh notes that *E. consobrina* is only a variety of *viridescens* as at that time he had all the intermediate grades. The only difference mentioned was the venation and a slightly yellowish instead of greenish color. As the character of the apical cell is of no value and all pale green *Empoascas* vary to yellowish, this can be accepted as final.

E. viridescens is described as:—head right angled, the apex rounding off, pale greenish, elytra subhyaline with a greenish tinge. A specimen from Rock Island varies in being more yellowish. Length not quite 1/8 in. *E. consobrina* varied only in being sometimes yellowish and slightly over 1/8 in. in length. *Chloroneura malifica* (omitting the variable cell character) is described in exactly the same language as that used for *viridescens* with the addition of "or yellowish" and elytra "at their extreme tip cloudy." Length 1/8 in. Curiously enough these are exactly the additions that the *consobrina* description brings to *viridescens* with one addition,—the cloudy tip,—a character often found in the potato leafhopper. There appears to be little doubt that these descriptions apply to the same species, the only reason for separating them in the first place probably being the unstable generic character.

Walsh calls *malefica* the "culprit leafhopper" and says "occurs on apple and pear leaves. Took a pair *in coitu* under bark, early in the spring, in the woods." In another place he states that this species and *maligna* are supposed to be the cause of fireblight. In the *Prairie Farmer* of the next year (April 4, 1863) he discussed this further in connection with eggs found in apple twigs which he identified as the eggs of *malefica*. This species hibernates in the adult stage which agree with his finding them under bark in the early spring but would not agree with his identification of winter eggs. A study of his description and figures of the eggs shows conclusively that they were those of a tree-hopper (*Ceresa*) and not of any leafhopper. As this is the only apple-infesting species of *Empoasca* that winters as an adult, there could be little question of the correctness of the determination on that ground alone, but when taken in connection with Walsh's accurate comparison with *maligna*, the other apple-infesting species, the identification is definite and complete.

This species is a much more serious pest of potatoes than it is of apples, in fact it is *not* ordinarily an apple pest but only a nursery stock pest. Although named *fabae*, it is only secondarily a bean pest and should undoubtedly be called the potato leafhopper.

Much additional confusion has arisen from the unstable character of the white markings of this species. A majority of the mounted material shows no markings at all—such examples are usually determined as *viridescens*. Others show three spots on the pronotum and a pale line on the scutellum and are often determined as *flavescens* while the few that show the complete spotting have been determined as *mali*.

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See Gillette, Fenton and Hartzell for further references.

Scientific Notes

Recurvaria nanella Hübner occurred in considerable numbers in the vicinity of Harrisburg, Pa., on peach, quince, sweet cherry and plum. The larvae caused considerable damage to the young leaves. In some instances as many as fifty per cent of the terminals were infested. The adult of this species was reared and identified by Mr. Carl Heinrich from material sent to him by the writers.

T. L. GUYTON and A. B. CHAMPLAIN, *Pa. Dept. of Agri., Harrisburg*

Destruction of Canada Thistles by *Pyrameis cardui* Linn. In north central and northwestern Ohio, the larvae of the Painted Lady butterfly have been found in great numbers feeding on Canada thistle. In some sections their abundance was so great that an uninfested plant could not be found. The leaves, blossoms and upper part of the stem were usually entirely destroyed. They attracted much attention and were widely heralded in newspapers as "new friends of the farmer."

C. R. CUTRIGHT, *Assistant Entomologist,*
Agricultural Experiment Station, Wooster, Ohio.

Strategus antaeus Injuring Peach. During the last week in June adults of this species were found burrowing under ground and girdling one- and two-year old peach trees in the vicinity of Harriman, Tennessee. Injury was quite severe only in those orchards that are located on new ground and with an abundance of oak stumps through the peach orchard. As the larvae of this species are known to feed on decayed oak leaves and roots, it is more than likely that they bred up from the decaying oak stumps. The injury first manifested itself by yellowing of the leaves and later by dying out completely.

S. MARCOVITCH, *Agr. Expt. Station, Knoxville, Tenn.*

The Western Corn Root Worm in Connecticut.— On August 29, 1923, the writer collected in the flowers of *Hibiscus moscheutos*, at Granby, Conn., two slender green Chrysomelid beetles. A visit to the same place on September 5 of this year showed me that these beetles were quite common on aster, calendula and some other kinds of flowers in the garden. This beetle has been identified as *Diabrotica longicornis* Say, by Mr. M. P. Zappe, Assistant Entomologist of this Station. This species, which has also been collected recently at Cornwall, Conn., by Mr. K. F. Chamberlain, occurs in the southern and middle western states, but it is believed that it has not heretofore been recorded from Connecticut.

W. E. BRITTON, *Conn. Agr. Expt. Station, New Haven, Conn.*

A European Leaf-Miner of Birch.— During the summer of 1923, in several localities in Connecticut, leaves of the gray birch, *Betula populifolia*, particularly those at the tips of young sprouts, were being mined by some larva which made a broad "blotch" mine. Some material was collected that season but the adults were not reared. This season at my suggestion, material was gathered by Mr. R. B. Friend, Assistant Entomologist of this Station. On August 6th, Mr. Friend obtained a number of small sawflies of both sexes. Specimens were sent to Mr. S. A. Rohwer of the U. S. National Museum who has identified it, at least provisionally, as the European *Fenusa pumila* (Klug) which up to this time was not known to occur in the United States. Dr. Felt informs me that he has observed the work of this leaf-miner generally in eastern New York State and also collected material.

W. E. BRITTON, *Conn. Agr. Expt. Station, New Haven, Conn.*

A spittle insect (*Lepyronia quadrangularis*) is causing noticeable injury to corn in Carroll County, Arkansas. In the infested area, covering several acres, the spittle insects could be seen on some plants in aggregations of 20 to 50, on the under surface of the leaves, in the axils and on the tassels. In some instances about a hundred insects were observed on a single plant. As a result of the attack, many of the plants had turned brown and the stalks were dying. The corn is near a timothy field which had been cut about two weeks ago. Apparently, the field was severely infested with the spittle insects, and when their food supply was taken away they migrated to the corn. Although so far as I know, *Lepyronia quadrangularis* has not been reported on corn, it apparently finds this host plant entirely satisfactory.

W. J. BAERG, *Entomologist*

Calcium Cyanide Kills Vespa infernalis; On Sept. 9th Dr. C. P. Gillette received a phone call asking for aid in destroying a wasp infesting a house in Fort Collins. The wasps were causing considerable annoyance in that members of the family were being stung quite severely. The writer was asked to look the situation over and advise a remedy.

The wasps were found to be inhabiting the house at some place between the sill and the foundation. Wasps were flying in and out in great numbers, and, due to the location, to gain access to the nest was impossible without removing part of the foundation. Burning sulphur fumes injected into the opening failed to give the desired results. Calcium cyanide was then tried. The dust was blown in between the entrance and the foundation, also a small amount of dust was applied to the ground just below the entrance. The results were interesting. None of the wasps on the outside of the nest were observed to pass in over the cyanide and make their way out again. Wasps on the outside would come in from the field, and in an endeavor to gain entrance to the nest, would be overcome by the cyanide and fall to the ground where they were killed by the cyanide there. A 100% kill was secured.

GEO. S. LANGFORD, *Colorado Agricultural College*

A New Egg-Parasite of the Codling Moth.— During the months of June and July 1924 while making field observations on the hatching period of the codling moth eggs on English walnuts in Ventura County, Calif. it was noticed that about 3 per cent of the eggs were parasitized.

The larval parasite was visible within the egg, moving nematode-fashion. When half grown its alimentary tract shows up clearly for it is brown in color and opaque. In the pupal stage the parasite is hidden from view by the blackening of the egg shell immediately above it. (This change in the egg shell also occurs when the larva of *Trichogramma minutum* pupates.) The newly formed pupa is light yellow and lies within the egg shell surrounded by masses of brown excrets.

About twenty of these parasitized eggs were brought into the laboratory. When the parasites had pupated they were removed from the nuts and placed in a petri dish where they emerged.

According to Mr. Timberlake this parasite is a species of the genus *Prospaltella*.

STANLEY E. FLANDERS, *Entomologist, Saticoy Walnut Growers Assn.*

Wireworms injuring sugar cane.—A report was received in June from a sugar plantation near Morgan City, La., that wireworms were injuring sugar cane in the lower fields. An investigation showed that about 250 acres of stubble cane has been completely destroyed, together with about 50 acres of plant cane. All was in reclaimed

land near the woods, where there were many pieces of rotten wood in which the insects feed. Further observations showed that a few of the wireworms were on higher ground.

Larval specimens submitted to Mr. J. A. Hyslop of the Bureau were determined as *Melanotus sp.*

Various experiments in the control of this pest have been started.

As far as known to the writers, this is the first report of wireworms seriously injuring sugar cane in Lousiana. It is believed that the land newly reclaimed from the swamp was naturally infested with them, and finding sugar cane at hand they turned their attention to this crop. They feed on the "eyes" of the planted seed cane, and bore into the young plants below the surface of the ground in a manner somewhat similar to the sugar cane moth borer, *Diatraea saccharalis*.

It is to be noted that corn in adjoining fields appears to be free of attack.

W. E. ANDERSON, *Louisiana State Entomologist*
T. E. HOLLOWAY, *Bureau of Entomology*

Wohlfartia vigil Walker Attacking Man.— A first stage larva about 0.6 mm. long, presumably of this species of flesh fly, was removed, along with several others, from the conjunctivae of a man affected with some conjunctivitis, and resident in Cattaraugus County, New York State. A very small cyst was observed, which contained several living maggots. Walker (Journ. Parasit., 7:1–7, 1920) has recorded two cases of infestation in 1920 and another in 1921 (Ibid. 9:1–5, 1922), all infants with the infestations characterized by boil-like sores on the exposed upper parts of the body, especially the neck and arms. This appears to be the first American record of adult infestation of the eye, such as is recorded for the European *W. magnifica*. Infestation is presumably most likely in heavy sleepers, especially somewhat defenseless young children.

E. P. FELT

The Apparent Eradication of the Argentine Ant from Fayette, Mississippi.— During the summer of 1922 the Argentine ant was discovered at Fayette, Mississippi by one of the Plant Board inspectors, Mr. G. W. Alexander.

A survey made during the late summer revealed the fact that the infestation covered only one and a half blocks. Realizing that the chances for eradication were remarkably good, the Plant Board advised the authorities to undertake successive fall campaigns for the purpose of eradicating the ants. The town authorities readily agreed to this, so in the fall of 1922 the writer and Mr. Alexander distributed 750 cans of poison throughout the infested area. This was at least twice the amount usually put on blocks of the same size in larger campaigns. At the time the poison was put out, the ants were sufficiently abundant to be seen here and there without any particular search for them.

The latter part of the next summer (1923), the writer visited Fayette and went carefully over the infested area hunting for ants, but only two small colonies were found. Conversations with people living in the infested area convinced the writer that the ants had become almost exterminated by the first poisoning. A second campaign was put on in the fall, the same amount of poison being used as previously.

In June, 1924, the writer spent almost two days going over the infested area hunting for Argentine ants but found none. Numerous native ants were present in the once infested territory, such species as the fire ant, *Solenopsis geminata* Fabr., the tiny black ant, *Monomorium minimum*, Buckley, the small sugar ant, *Prenolepis*

nylanderia and *Pheidole dentata* Mayr. being unusually common. Not a person in the area could be found who has seen or been troubled by the Argentine ant since the second batch of poison was put out.

It is, of course, a little early to say positively that the Argentine ant has been eradicated from Fayette, yet the writer has every reason to believe, and does believe quite positively that the pest has been eradicated from this town.

So far as known no other town in the United States has ever accomplished eradication of the Argentine ant. This experience should be an incentive to other towns to fight the ants as Fayette has done.

M. R. SMITH, *Ant Specialist, Mississippi State Plant Board, A. &. M College, Mississippi.*

The so-called Cotton Flea.— During 1923 and 1924 considerable attention has been attracted principally in southern Texas to a new and severe form of injury to cotton. The very young squares are blasted, the number of fruiting branches is reduced and the main stem of the plant grows excessively tall. All varietal characteristics are obliterated and the plants resemble "sterile rogues." This injury reached its climax in South Texas in 1923. During that season the loss from this cause was much greater than from the boll weevil. In hundreds of fields no crop whatever was produced. In 1924 the injury has been much less but is still very considerable in Calhoun and neighboring counties on the coast of Texas. In one field recently (July, 1924) examined only 765 bolls were found on 1000 plants. What appears to be the same form of injury, has recently (July, 1924) been reported from Georgia and South Carolina.

It is the consensus of opinion among farmers in Texas that the injury is caused by an insect, *Psallus seriatus* Reuter, a Capsid, is the species generally pointed out. This insect was reported as an enemy of cotton some years ago by Dr. L. O. Howard on material submitted by the late J. D. Mitchell of Victoria, Texas. It is recorded by Van Duzee from Texas, Arizona, New Mexico, Florida and various northern and other western states.

During 1923 an investigation of this problem was undertaken in Texas. It dealt largely with epidemiological considerations. The results obtained suggested that the so-called flea might have a connection with the injury described. During 1924 exact experiments were conducted in Calhoun County, Texas, in which, by the application of dust insecticides beginning early in the season the hopper was eliminated from the series of plots in different fields, the plant reactions being carefully observed in the treated and untreated areas. Other experiments have dealt with the introduction of large numbers of hoppers into cages in which cotton plants are growing. The work has not yet advanced far enough to warrant any very definite conclusions but there are strong indications that the insect transmits a virus of some kind, thus bringing about the profound changes in the habit of growth of the plant, which are entirely out of proportion to the number of the insects which have ever been found in the fields. A full report on these experiments including the results of observations on the occurrence of the trouble in Texas and other states will be prepared at the end of the season.

W. D. HUNTER, *Bureau of Entomology*

Notes on Winter Mortality of the three Coccids ***Pseudaonidia duplex*** **(Ckll.),** ***Chrysomphalus aonidum*** **(Linn.), and** ***Chrysomphalus dictyospermi*** **(Morg.), at New Orleans, Louisiana.** On January 6, 1924 when the official minimum temperature of

19°F. was recorded in New Orleans, much of the sub-tropical vegetation was severely frozen and many of the more tender plants killed.

In connection with the semi-weekly studies of the seasonal history of the camphor scale, *Pseudaonidia duplex* (Ckll.), on camphor trees, data secured on the mortality of the insects from natural causes,[1] from natural enemies and from freezing, pointed to a distinct increase in the number of dead scales following the cold weather. In these studies it was observed that the body contents of adult female scales, which had died from natural causes or had been killed by parasites or predators were dried or eaten and their appearance was not changed by freezing. The scales recorded as frozen showed a collapsed body wall, oily appearance and discoloration, a condition distinctly different from that of the insects dead from other causes, and this condition indicated that before being frozen the body contents of the frozen scales were normal and these scales living.

The records of the mortality from various causes were determined by counts of material taken from the same twigs at the same time, so that the gradual rise during the winter in the natural mortality does not influence the results. The number of scales recorded as killed by natural enemies after the drop in temperature was about 2% less than the number dead from this cause during the four weeks preceding the cold. No consideration has been given to the influence on the counts of the dead scales which loosened and fell off as the study progressed and it is quite probable that many of the frozen scales were handicapped by a low vitality or an exposed position so that they would have succumbed naturally to the climatic changes of a more normal winter.

The comparison is made of results of observations on the mortality of the camphor scale from January 22, 1924, 16 days after the freeze, at which time the insects had reacted to the cold sufficiently to give accurate information, to February 29, 1924, a total of 12 examinations. The examination of 5225 adult female scales at 12 semi-weekly intervals during this period, showed 2660 or 50.91%[2] dead. Of these 1576 or 30.16% of the total number examined were recorded as killed by natural causes, 840 or 16.08% by freezing, 138 or 2.64% by parasites, and 106 or 2.03% by predators.

Observations during the four weeks previous to the low temperatures showed that 1047 or 28.31% of the 3698 adult female scales examined were dead from natural causes and natural enemies.

Records of the examination of 1859 female camphor scales, collected March 8, 1924 on *Citrui trifoliata* growing below buds of Satsuma orange trees five miles south of Mobile, Alabama, where the minimum temperature is said to have ranged from 10° F. to 14°F. on January 6, 1924, showed 1100 or 59.17% of the total scales dead.

No decrease in the number of natural winter eggs per female has been apparent and in other respects the surviving over-wintering females appear normal. All live male scales had issued from beneath their coverings previous to the freeze.

The data secured from examinations of the Florida Red Scale, *Chrysomphalus aonidum* (Linn), collected on camphor leaves at New Orleans, La. showed 40.08% of the adult female scales dead from natural causes and natural enemies during the

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[1]This term is used in this note to cover all causes of mortality other than insect parasites, predators and freezing.

[2]Calculation of two decimal places has been a routine practice in our studies. Special significance is not claimed here.

month preceding the cold weather. Observations on 2489 adult insects on February 2 and 8, following the freeze, showed but 2 alive, a mortality of 99.91% and neither of these living females was producing progeny. During the examinations at this time not a living crawler was seen and only 36 eggs which were judged to be normal.

The studies of the *dictyospermum* scale, *Chrysomphalus dictyospermi* (Morg.) collected at New Orleans, La. on camphor leaves on the 4th and 9th of February 1924, showed 10 living scales in a total of 2428, a mortality of 99.58% while before the freeze only 22.16% of the adult female scales were dead. Mortality among the eggs and crawlers was also very high, only three viable eggs and one active crawler being found during the examinations, and all producing females were dead.

All material used in the observations was taken from living plants and every effort was made to represent normal conditions.

Since *Chrysomphalus aonidium* and *dictyospermi* are primarily leaf-infesting coccids and many of their favorite host plants are completely defoliated, this condition, combined with the almost complete mortality from freezing, seems to have temporarily eliminated these species from the list of economic insect pests in New Orleans. However, the apparent greater resistance to cold of *Pseudaonidia duplex* (Ckll.) seems to add to its possibility as a national economic pest.

THOS. F. CATCHINGS and W. D. WHITCOMB,
U. S. Bureau of Entomology, New Orleans, La.

THIRTY-SEVENTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The thirty-seventh annual meeting of the American Association of Economic Entomologists will be held at Washington, D. C., December 31, 1924 to January 3, 1925, inclusive. Final arrangements with reference to meeting places are not yet completed.

Hotel headquarters for the Entomologists will be at the Harrington, 11th and E Streets. Rates as follows:

Single room, without bath	$3.00
Double room, " "	4.00
Single room, with bath	3.50
Double room, " "	5.00 to 6.00

Members are urged to make reservations as soon as possible.

The Section on Apiculture will meet at 9:30 a. m., Wednesday, December 31st. The section on Horticultural Inspection will meet at 1:30 p. m. on the same day.

The opening session of the general Association will be held at 9:30 a. m., Thursday, January 1st, 1925. On that evening at 8 o'clock the meeting of the Insect Pest Survey and Extension Entomologists will be arranged.

Applications for membership should be filed with the Secretary as soon as possible and should be accompanied with fee of $4.00. Blanks can be secured from the Secretary or the Chairman of the Membership Committee.

C. W. COLLINS, *Secretary, Melrose Highlands, Mass.*

SECOND ROCKY MOUNTAIN CONFERENCE OF ENTOMOLOGISTS

We felt that the first Rocky Mountain Conference of Entomologists held in Pingree Park, Colorado, last year was quite a success, but the one held this year, August

18–23, in the same place far excelled in attendance and in the interesting program. Twelve states were represented, and the entire group, including the families of the various entomologists, numbered fifty. Everyone entered into the spirit of the occasion with the result that all left very much better acquainted and feeling that they had not only had a very interesting and profitable meeting, but that it was as well a very pleasant vacation. We had some tireless collectors of both insects and fish, which resulted in many of both being taken.

A very interesting part of the program was a ten-minute impromptu report on the insect conditions in the twelve states represented. The following are some of the principal subjects that were discussed. All of the papers and discussions were very informal and for that reason proved the more valuable.

Are Insects Animals?—Dr. Wm. A. Riley
Alfalfa Stem Nematode—Dr. C. P. Gillette
Colorado Wild Flowers—Miss Caroline Preston
The Pea Aphis as Affecting Alfalfa—Dr. R. C. Smith
Pea Aphis Predators— C. L. Fluke
Notes on Cicadae—R. H. Beamer
Notes on Homoptera—Dr. Paul B. Lawson
The 1924 Campaign for the Control of the Alfalfa Weevil in Idaho—F. E. Whitehead
The Alfalfa Weevil Situation in Colorado—J. H. Newton
Sugar Beet Insect Problems in Colorado—A. C. Maxson
Sugar Beet Insect Problems in Utah and Idaho—E. G. Titus
Extension Entomology—C. R. Crosby
The Long Time Extension Program—Otis Wade
How to Determine the Hessian Fly Free Date—Dr. C. J. Drake
Improvement of Spray Practices for Codling Moth Control—J. H. Newton.

This program does not begin to represent the variety of subjects that were discussed during the week. Time did not permit of a number of papers that were pre pared, but all felt that the informal discussions had been invaluable.

The various contests and impromptu entertainments served to get all acquainted. Dr. C. R. Crosby won the prize for the best mustache grown during the week, but this is being contested by C. L. Fluke on the grounds that the points of brilliancy and area were given too much weight by the judges.

It was unanimously voted to hold the Conference again next year at the same place and at approximately the same time of the year. The officers elected were C. P. Gillette, Chairman, C. J. Drake, Vice-Chairman, and George M. List, Secretary.

George M. List, *Secretary, Second Rocky Mountain Conference of Entomologists*

FIFTH ANNUAL MEETING OF THE NORTHEASTERN ENTOMOLOGISTS HELD AT PHILADELPHIA AND VICINITY JULY 30 TO AUGUST 1, 1924

The Entomologists of Northeastern United States, with a generous number of visitors interested in entomological problems, assembled at the Japanese Beetle Laboratory, Riverton, N. J., on the morning of July 30. The morning was occupied by making an inspection of the laboratory facilities and the experiments under way. The parasite house was of much interest as several thousand flies had recently been bred and liberated in the infested area. These flies were secured in Japan the native

home of the Japanese Beetle, by experts of the U. S. Bureau of Entomology. It is too soon to know just what these parasites will do in this country but much hope is held for their permanent establishment. In the insecticide part of the laboratory a very interesting development was shown in fractioning oil of sassafras. This oil has proved to be decidedly attractive to the Japanese Beetle and has many possibilities when used with a poison bait or in spray materials. For the destruction of the grub of the beetle the carbon bisulfid emulsion developed at the laboratory is still the most dependable and cheapest fumigant. Oil of the American Chenopodium has also been used as well as solutions of arsenate of lead. In the protection of the foliage from attacks of the Japanese Beetle the development of arsenate of lead coated with an insoluble soap seems to be the most effective measure yet tried. The use of flour as a sticker at the rate of two pounds to 50 gallons of spray and three pounds of powdered arsenate of lead gave very good foliage protection in apple, peach and cherry orchards. In connection with the development of attractive oils for the beetles, tests using different colors have been tried as an attractive agent. Up to this time red seems to be the most attractive color.

Lunch was served at the clubhouse of the Riverton Country Club, after which brief reports were presented by Mr. L. B. Smith and members of the staff at the laboratory, concerning different phases of the Japanese Beetle work.

The afternoon was spent in visiting different orchards in the infested territory and observing results of the remedial measures, and examining a number of experimental areas.

In the evening the Entomologists met in joint session with members of the American Entomological Society, in the Auditorium of the Academy of Natural Sciences in Philadelphia. Dr. P. P. Calvert presided at this session and brief addresses were made by Mr. J. M. McKee, Assistant Secretary of Agriculture of Pennsylvania, A. F. Burgess, President, American Association of Economic Entomologists, and J. L. King of the Japanese Beetle Laboratory, who gave an interesting account of his explorations in Japan and Korea. This session was largely attended, the entire seating capacity being occupied.

The following day was occupied in visiting field laboratories and experimental plots. At the Bustleton Laboratory of Pennsylvania State College, interesting experiments were observed in the control of wire worms by fumigating the soil through the use of calcium cyanide before planting. The experiments were not complete but no injury could be noticed in the crop and from preliminary experiments it seems that this is a very promising way of clearing the soil of larvae. At the Willow Grove laboratory of the U. S. Department of Entomology and the Pennsylvania Bureau of Plant Industry, methods of fumigating green-houses were illustrated, in which dust of calcium cyanide was the source of the hydrocyanic acid. This method seems to be quite promising. The rate at which the cyanide is now used is one ounce of the granular form to 100 cubic feet for one hour. It may be that this amount will be considerably lessened and that the time of fumigation will be made longer. A brief, but very interesting stop was made at Valley Forge during the afternoon. Near West Chester, Pa., the orchards in which experiments are now in progress in the use of scalecide and sulphur products as carried on by the Crop Protection Institute, were visited. The scalecide experiments were not far enough advanced to give definite information at present. Several of the colloidal sulphurs and different types of precipitated sulphurs have given apple scab control and seem quite promising as spray materials.

Late in the afternoon the party assembled at the club house of the Westtown School, where a complimentary luncheon was provided by the Delaware-Chester Fruit Growers Association. Prior to the luncheon the entomologists had an opportunity to swim in the river near the club house, and in the early evening the meeting was called to order by Chairman Hodgkiss, who introduced Mr. Wm. Vandergrift, who responded in behalf of the Fruit Growers Association. Dean Stanton of the Westtown School also extended a welcome to the visiting entomologists. A short business session was held and the report of the nominating committee consisting of A. F. Burgess, T. J. Headlee and C. H. Hadley, was received, and nominees for officers for the ensuing year were duly elected as follows: Chairman, E. N. Cory, College Park, Maryland. Secretary, C. H. Hadley, Harrisburg, Pa. It was voted on recommendation of this Committee that the next meeting be held in Maryland. The following resolutions were unanimously adopted: *Resolved*, That the thanks of this meeting be extended to the Philadelphia Academy of Sciences and the American Entomological Society of Philadelphia, for the use of the Auditorium of the Academy and for many courtesies which materially contributed to the comfort and success of the meeting. *Resolved* that the thanks of the meeting be extended to the Delaware-Chester Fruit Growers Association for the generous entertainment provided, and to Dean Stanton of the Westtown School for the courtesies extended and to the local Entomologists and all others who assisted in arranging the program and making this meeting a decided success. Chairman Hodgkiss introduced a number of entomologists who briefly discussed the following topics: W. C. O'Kane, The Work of the Crop Protection Institute. A. F. Burgess, The Oriental Hag Moth. I. M. Hawley, Entomological Problems in Utah, T. J. Headlee, The Oriental Peach Moth. Other speakers included E. M. Cory, W. A. Hooker and Philip Garman. The party adjourned, most of the members spending the night at West Chester, Pa.

On Friday morning August 1, a trip was made by automobile from West Chester through Wilmington, Delaware, crossing the ferry at that point to the New Jersey side. Delaware extended a cordial greeting by having the procession escorted through the city of Wilmington by two members of the State police mounted on motor cycles. At the Sea-Brook farms in New Jersey, experimental plots of the New Jersey Experiment Station were visited, where various sprays and dusts are now being tried in an attempt to control the Oriental Fruit Moth. The plots seem to be fairly free from the attack of the larvae of the moth but the season is hardly far enough advanced to make any definite statements. It was pointed out by Mr. L. A. Stearns in charge of these plots, that early spring cultivation has much to do with the number of emergences of the moths wintering over in the soil. In a cage in which no cultivation took place sixty moths emerged from under one tree, while in a cage in which plowing and harrowing was done no moths emerged. An estimate was made that 75% of the larvae found wintering on or in the ground were destroyed by thorough cultivation; the Oriental Moth is unable to emerge when buried in soil three inches deep. At Glassboro, orchards were visited in which coated arsenate of lead was used in the regular spray schedule and the use of this insecticide in general orchard practice seems promising. Through the courtesy of Dr. T. J. Headlee, a number of the entomologists had an opportunity of visiting the cranberry growing section of New Jersey after the orchards at Glassboro were examined. The other members of the party returned to Camden and Philadelphia.

Nearly a hundred attended the meeting and all were well pleased.

The following is a partial list of those present.

A. L. Quaintance, Washington, D. C.; J. R. Eyre, North East, Pa.; J. R. Stear, Chambersburg, Pa.; David E. Fink, Riverton, N. J.; C. M. Craighead, Guersuey, Pa.; Dwight F. Barnes, Melrose, Mass.; P. R. Myers, Carlisle, Pa.; H. B. Seaver, New Brunswick, N. J.; L. R. Cagle, Leesburg, Va.; G. M. Vunderhill, Richmond, Va.; H.W. Wenzel, Philadelphia, Pa.; H. Hornig, Philadelphia, Pa.; A.B. Champlain, Harrisburg, Pa.; Charles Weigel, Washington, D. C.; Charles Doucette, Willow Grove, Pa.; C. H. Hadley, Harrisburg, Pa.; F. L. Holdridge, Lancaster, Pa.; Ernest N. Cory, College Park, Md.; H. A. Aimes, Bound Brook, N. J.; C. W. Collins, Melrose Highlands, Mass.; C. E. Hood, Melrose Highlands, Mass.; C. W. Minott, Melrose Highlands, Mass.; Saul Phillips, Albany, N. Y.; W. S. Hough, Winchester, Va.; Frank H. Lathrop, Poughkeepsie, N. Y.; A. C. Baker, Washington, D. C.; M. R. Ross, Vineland Sta., Ontario, Canada; Louis A. Stearns, New Brunswick, N. J.; Theo L. Bissell, Westover, Maryland; Fred H. Worsinger, Jr., Holmesburg, Phila., Pa., A. W. Buckman, So. Langhorne, Pa.; M. P. Zappe, New Haven, Conn.; Q. S. Lowry, Boston, Mass.; J. M. McKee, Harrisburg, Pa.; V. I. Safro, New York, N. Y.; M. T. Smulyan, Melrose, Mass.; C. W. Stockwell, Riverton, N. J.; Edward L. Crabbe, Toms River, N. J.; H. B. Scammell, Toms River, N. J.; Charles S. Beckwith, New Brunswick, N. J.; Ray Hutson, New Brunswick, N. J.; W. C. O'Kane, Durham, N. H.; C. R. Orton, State College, Pa.; G. W. Howard, Albany, N. Y.; H. L. McIntyre, Albany, N. Y.; H. L. Blaisdell, Melrose, Mass.; G. A. Smith, Boston, Mass.; C. C. Wagoner, Highland, N. Y.; R. B. Friend, New Haven, Conn.; J. A. Hambelton, Washington, D. C.: Reginald Wooldridge, Melrose, Mass.; John T. Ashworth, Danielson, Conn.; A. E. Stene, Kingston, R. I.; Dettman W. Jones, Arlington, Mass.; D. C. Blanke, New York, N. Y.; William W. Chafman, 134 So. 2nd St., Phila., Pa. P. D. Sarders, College Park, Md.; B. G. Pratt, New York, N. Y.; C. F. W. Muesebeck, Melrose, Mass.; William Moore, New York, N. Y.; I. M. Hawley, Logan, Utah; I. L. Sherman, Newport, R. I.; T. L. Guyton, Harrisburg, Pa.; H. I. Winchester, Melrose Highlands, Mass.; Philip Garman, New Haven, Conn.; C. C. Hamilton, College Park, Md.; H. E. Hodgkiss, State College, Pa.; E. R. Van Leeuwen, Riverton, N. J.; Lorran B. Smith, Riverton, N. J.; Philip P. Calvert, Philadelphia, Pa.; A. F. Burgess, Melrose Highlands, Mass., J. L. King, Riverton, N. J., B. R. Leach, Riverton, N. J., W. Rudolf, New Brunswick, N. J.; C. C. Hill, Carlisle, Pa.; Wm. A. Hooker, Washington, D. C., Wm. R. Walton, Washington, D. C., Chas. K. Hallowell, Philadelphia, Pa.; Thos. J. Headlee, New Brunswick, N. J.; Thos. B. Symons, College Park, Md.; Js. Fine c/o Jas. Good, Inc., Philadelphia, Pa.; A. B. Wells, Bryn Athyn, Pa.; F. M. Trimble, Harrisburg, Pa.; Geo. F. Johnson, Harrisburg, Pa.; H. B. Kirk, Harrisburg, Pa.; R. A. Sheale, Providence, R. I., and Carl Ilg, New Brunswick, N. J.

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OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

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The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $3.00 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

Separates or reprints, if ordered, when the manuscript is forwarded or the proof returned, will be supplied to authors at the rates given below. Note that the number of pages in a reprint may be affected somewhat by the make-up, and that part of a page is charged as a full page. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

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There is perhaps no phase of economic entomology requiring more discretion in its administration than that relating to plant quarantines. The conference of Federal and State officials last April summarized in our issue for June 1, pages 431–433, formulated a program which leaves little to be desired in the way of a working agreement. Recent advices from the chairman of the conference informs us that all the States in the Union and in addition Porto Rico, Guam, Hawaii and British Columbia have now ratified the agreement. This is a notable step in the right direction and should be followed as soon as possible by such modifications in regulations and practices as to put it into full effect. Even then there will be a multiplicity of nice points requiring decision from time to time.

The report of the Rockefeller Foundation for 1923 contains an account of the attempt to eradicate yellow fever from Brazil and records an absence of cases from Mexico, Central America, Ecuador and Peru. It suggests the ultimate eradication of this scourge from the entire world. The report also discusses the malarial control work started in 1916, special attention being given to rural areas. Last year special malarial investigations were carried on in the United States, Brazil, Nicarauga, Palestine, Philippine Islands, Salvador and Porto Rico. The work of the Foundation, world wide in scope, affords additional proof that under ordinary conditions many communities can reduce malaria to an almost negligible point and at a per capita cost within the limits of local taxation. These great benefits to humanity are striking illustrations of applied or economic entomology, since the control of

both yellow fever and malaria is dependent upon the control of the carrier mosquitos. Can wealth and ability do better than make possible the alleviation of human suffering? The Foundation is one of the noblest conceptions of man. All honor to its founder and his associates.

The Rensselaer Polytechnic Institute, located at Troy, N. Y., celebrated its hundredth anniversary this month. It is the oldest engineering school in the country. Two items of general interest though apparently of little concern to entomologists until we turn to the early history of the institution and find that not only did it recognize the natural sciences but actually gave work in entomology. Ebenezer Emmons, the author of an extended general work on New York insects published in 1854, was graduated in 1826 and Asa Fitch, the first "official entomologist" in the United States received his degree in 1827. The work of the latter is too well known to require more than mention. The character of his work shows that sound training in the fundamentals, even if but little of it relates directly to insects, makes possible the interpretation of many mysteries presented by the Hexapoda. The Rensselaer Polytechnic Institute, through Fitch, profoundly influenced the development of economic entomology in this country. It is fitting that we recognize the debt owed to men in technical schools who gave incidental training in entomology at a time when little training in natural philosophy was considered sufficient.

Reviews

Manual of Tree and Shrub Insects. By Ephriam Porter Felt, 382 pages, 256 figures, The Macmillan Co., New York, 1924, Price $3.50.

A compact and comprehensive manual of shade tree insects has long been needed. Packard's Fifth Report of the U. S. Entomological Commission published in 1890, contained a vast amount of information, much of it descriptive, but was arranged in the form of a catalogue without giving a birds eye view of the subject, or the proper perspective. Of course the control measures mentioned in Packard's work are now mostly obsolete. Dr. Felt's two-volume work, "Insects Affecting Park and Woodland Trees" published in 1905-6, has for nearly twenty years been a standard reference work in every entomological library, but it was too large and cumbersome to be convenient for ready reference. Then in 1918 came Houser's Bulletin 332 of the Ohio Agricultural Experiment Station on "Destructive Insects Affecting Ohio Shade and Forest Trees," which answered the purpose for a time, though I am told that it can no longer be supplied.

Therefore the appearance of a new book for which there is a need is an occasion for rejoicing: doubly so when its author is one of the best authorities in this country on

the subject. Dr. Felt's new book is one of the Rural Manuals and is of convenient size and generally attractive make-up. It is arranged in three parts: Part I contains general information about the structure, transformations and origin of insects, a list of introduced pests, literature, and accounts of the natural checks and artificial methods of controlling insect pests. Part II contains a brief account of each of the more important shade tree insects grouped according to the particular kind of injury which they cause. Part III deals in a similar manner with forest insects, and Part IV is a systematic account of the more important orders of insects, each order being illustrated by a few species connected with trees or shrubs.

In any work of this size and scope, much must be omitted, and many species included by mention only. Probably no two entomologists would agree on just what species should be included or their relative importance. Nevertheless, the critical reader may wonder why twenty-two pages are devoted to "Plant Galls and Gall Insects" when only twenty pages are given to "Scale Insects" and twelve to "Plant Lice or Aphids." There may also be some difference of opinion about the value of mentioning in a popular work a large number of forest bark beetles about which little or nothing is known, and which can be identified only by specialists. Some errors are bound to appear in a work of this sort (See Figure 131, duplicated in Figure 186) but these can be corrected in subsequent editions. The casual reader in looking over the volume and noting the references may get the idea that the book was written for the people of New York State, or that most of the work on shade tree insects has been done by its author. In my opinion the author's greatest sin lies in giving so many references to his own publications and overlooking or omitting a number of rather important ones published elsewhere. For instance on page 53 at the end of the account of the Bronze Birch Borer, Cornell Bulletin 234 by Slingerland might well be cited as it probably represents as much original work as either of those mentioned, and perhaps more. Citation of references more widely scattered would make the book more useful to readers over a wide geographical area. So far as is possible such citations should refer to publications making some contribution to a knowledge of the subject. Even in the systematic portion, such papers as Funkhouser's on the treehoppers and Fulton's on the tree crickets are omitted.

In spite of the possible criticisms mentioned above, Dr. Felt's book will prove a very useful volume and he should be congratulated by all entomologists on his accomplishment.

W. E. BRITTON

Guide to the Insects of Connecticut, Part IV, the Hemiptera or Sucking Insects, by W. E. BRITTON and COLLABORATORS. Connecticut State Geological and Natural History Survey, Bulletin No. 34, pages 1 to 807, plates 1 to 20, 1923.

This is an extended distributional and descriptive account with numerous keys, of the bugs of Connecticut prepared under the direction of Dr. Britton in collaboration with a number of experts, mostly well known, in the different groups, namely, Messrs. Abbott, Baker, Barber, Davis, DeLong, Funkhouser, Knight, Maxson, Osborn, Parshley, Stearns, Torre-Bueno, Van Duzee, Wilson, and Miss Patch. This publication is one of a series, the first being a general account by Dr. Britton, the second a discussion of the Euplexoptera and Orthoptera of Connecticut by Mr. Walden, and the third, as voluminous as the fourth, an account of the Hymenoptera or

wasp-like insects of Connecticut. The last, like its successor, was prepared through the collaboration of a group of experts. There is, in addition, a check-list of the insects of Connecticut by Dr. Britton, all published as bulletins of the State Geological and Natural History Survey.

This series, with numbers presumably to follow, affords a most substantial basis for further investigations, since it is well recognized that the classification and description of adult or perfect insects forms only a part of the entomological information which should be available. The economic entomologist, in particular, must know the immature stages and until these have been discovered and carefully studied in relation to plants and other animals, it can scarcely be claimed that our insect fauna is well known.

It is a source of regret on the reviewer's part that these works could not have been given a wider scope and have treated of the fauna of the northeastern United States, since many of the genera and species found in Connecticut occur over a much wider area. The reviewer would also suggest the advisability of more illustrations designed especially to give the general character of the adults and so far as possible, of the immature stages. Such figures would add greatly to the value of this series for the amateur entomologist and prove no small factor in awakening interest among those with inclinations toward natural history.

Dr. Britton is to be congratulated upon his progress in making known the Insects of Connecticut through this series of publications. There is certainly no local scarcity of insects. It may be stated in conclusion that corrections and additions to the volume on Hemiptera are now being published and will be sent on request to everyone who has received a copy of the work.

E. P. Felt

Current Notes

Mr. F. E. Whitehead has been appointed extension entomologist and associate professor of entomology at the University of Idaho.

Dr. F. C. Bishopp of the Dallas, Texas, Laboratory of the Bureau of Entomology, visited Omaha, Nebr., July 2, to appear as an expert witness in an insecticide case.

Mr. Vernon R. Haber has been appointed an Assistant Professor in Zoology at Pennsylvania State College, State College, Pa.

Mr. G. L. Davis has been appointed deputy nursery inspector at the Missouri Station in place of O. C. McBride who resigned to accept a position at the Minnesota Station.

On June 3, 1924, the degree of Doctor of Philosophy was conferred by the State University of Iowa on J. L. Horsfall, Associate Professor of Economic Entomology at Pennsylvania State College.

Mr. H. L. Weatherby of the Bureau of Entomology recently returned from a scouting trip for the Mexican bean beetle through Georgia and South Carolina. At the present time he is scouting in Virginia and West Virginia.

Mr. H. G. Barber, Roselle, N. J., was employed during the month of July as a specialist in Hemiptera at the U. S. National Museum, and during this time he arranged and determined the Nearctic collection of the family Coreidae.

Mr. J. U. Gilmore, of the Tobacco Insect Laboratory of the Bureau of Entomology at Clarksville, Tenn., visited Dillwyn, Va., recently for the purpose of investigating damage to young tobacco plants by an undetermined species of insect.

Mr. J. R. Horton, in charge of the Wichita, Kans., field station of the Bureau of Entomology, was called into consultation on account of the grasshopper outbreak in Oklahoma during early July. At the present writing the situation seems to be under control.

According to *Science*, at the University of Minnesota there has been organized an expedition to the Hawaiian Islands to study the marine fauna and flora. Doctors W. A. Riley, Royal N. Chapman and W. E. Hoffman will represent the departments of Entomology and Zoology.

Dr. L. O. Howard, Chief of the Bureau of Entomology, spent several days in southern California, prior to his departure for Honolulu, visiting the Bureau stations at Alhambra and Riverside, and consulting with the various entomologists, both Federal and State, located in that vicinity.

Mr. W. J. Phillips of the Bureau of Entomology visited Greensboro, N. C., July 4, to investigate an infestation of the wheat jointworm, and found a very abundant occurrence of this insect in that vicinity. An infestation of 100 per cent. was found in one field.

According to *Experiment Station Record*, Mr. A. L. Strand who recently resigned as assistant extension entomologist at Pennsylvania State College, has been appointed assistant entomologist at the Minnesota University and Station vice Dr. J. R. Parker who has returned to the Montana Station as associate entomologist.

Visitors to the Bureau of Entomology laboratory at Fort Valley, Ga., during the last month, to observe the work under way, included a group of Tennessee peach growers headed by the horticulturist of the University of Tennessee and several from South Carolina, Alabama, and Virginia.

Mr. J. E. Graf, for many years in charge of field operations in connection with Truck Crop Insect Investigations in the Bureau of Entomology, and for some months Entomologist Acting in Charge of these investigations, has been selected as head of the division, effective June 1, 1924.

Injury to elm foliage in southern Quebec proves to be the work of *Kaliofenusa ulmi* Sundewal, the Imported Elm Leaf Miner. The distribution of the injury has not yet been determined but is reported to cover a very large area in the southern part of Quebec province.

Mr. L. H. Worthley, in charge of corn borer control, left Arlington, Mass., during the week of July 25, going to Cleveland, Ohio, where he was located for several weeks to supervise the initiation of the scouting and quarantine work in the Lake regions. He visited New Haven, Conn., on September 3.

Mr. M. R. Smith, assistant entomologist and ant specialist of the Mississippi State Plant Board has obtained a leave of absence effective September 1st in order to pursue post graduate work at the University of Illinois, leading to the degree of Doctor of Philosophy.

A co-operative project between the Bureau of Entomology and the Bureau of Standards has been inaugurated, having for its object a thorough study of the elec-

trical effects in insecticide dusts. V. E. Whitman, of the Bureau of Standards, has been assigned to the problem. The field work will be carried on at Tallulah, Ia.

Mr. John R. Greeley was employed temporarily at the U. S. National Museum, for the last fifteen days in June assisting Mr. McAtee in arranging part of the Hemiptera collection. During the remaining portion of the summer season Mr. Greeley will work under the Biological Survey, and in the fall will return to Cornell to carry on his university studies.

Mr. James Zetek and family of Panama, visited the U. S. National Museum recently. Mr. Zetek has collected a great deal of fine material which has been sent to the Museum for identification and addition to the collection, and has spent considerable time collecting nests, termites, and wasps, and also a series of some of the rare Panamanian ants.

Mr. J. R. Horton, Entomologist in Charge of the Wichita, Kansas, laboratory, and A. F. Satterthwait, Entomologist in Charge of the Webster Groves, Mo., laboratory, attended the meeting of entomologists and agriculturists who met at Kansas City, Mo., in May to discuss and put into operation methods of control for chinch bugs and the Hessian fly in Kansas, Missouri, Nebraska and Oklahoma.

Dr. W. M. Mann of the Bureau of Entomology sailed for Europe on July 19, to be gone for several months. He will go to Spain in connection with some work for the Federal Horticultural Board. He also intends to visit Dr. Wasmann, the eminent Dutch entomologist, at St. Ignatius Kollege, Valkenburg, Holland, for the purpose of studying his collection of ants and beetles.

Dr. F. C. Craighead, of the Bureau of Entomology, left Washington on June 19 for an extensive trip to inspect the work at the various Forest Insect field stations, and also the co-operative work being conducted at the Forest Service experiment stations; both the Kaibab Project in Utah and the Southern Oregon-Northern California Project, the largest bark-beetle control projects ever instituted by the Government, will be inspected.

Mr. C. H. Popenoe, Bureau of Entomology, in charge of the truck-crop insect work at the Silver Springs, Md., laboratory, visited Pomeroy, Pa., and vicinity to investigate an outbreak of insects in mushroom houses. It was first reported that mites were the cause of the trouble, but upon investigation Mr. Popenoe found that springtails were the principal insects concerned. Co-operative experiments with the mushroom growers have been initiated.

Messrs. Kenneth Auden and A. R. Graham were reappointed as Insect Pest Investigators for the Entomological Branch, Canadian Department of Agriculture, and reported for duty, the former at Vernon, B. C., May 15, and the latter at Aylmer, Quebec, June 1. Mr. R. S. Hawkins, temporarily appointed as Insect Pest Investigator, reported for duty at Fredericton, N. B., on May 28. Miss D. F. Forward appointed temporary laboratory assistant, began her work on June 24.

Since Dr. McDunnough took up the study of the Ephemeridae several years ago, he has described 59 species, the types of which are deposited in the Canadian National Collection. This collection now contains representatives of over one hundred and fifty North American species (about two-thirds of the known species from this region) and is without doubt one of the most complete collections of North American May flies in existence.

The corn borer investigational work under way at Sandusky, Ohio, almost completely escaped the effects of the terrific storm which swept over that locality in the latter part of June. The most serious result of the storm was the partial wrecking of one of the motor boats assigned to the corn borer control work, which was capsized and sunk in shallow water. Arrangements have been made to raise and repair the boat.

The U. S. Civil Service Commission announced an examination for assistant entomologists, applications closing August 12. This examination is for the purpose of preparing a list of eligibles to fill vacancies in the Bureau of Entomology at an entrance salary of $2,400.00 a year. The duties of the position are to conduct experiments with insecticides in the control of Japanese beetle grubs, and in the utilization of bacterial and fungous diseases against the Japanese beetle.

During the month of July, Dr. W. D. Funkhouser returned to the U. S. National Museum the last lot of Membracidae belonging to the Goding collection. The Goding collection had been sent to Dr. Funkhouser for study in three different lots. Dr. Funkhouser has kindly examined each specimen, corrected the identification, and prepared a very complete report, so that it will be possible to incorporate this collection with the rest of the Museum material of the family Membracidae.

Mr. J. S. Houser of the Ohio Agricultural Experiment Station was a visitor at the Vincennes, Ind., laboratory of the Bureau of Entomology on June 30 and July 1. Mr. Houser was completing a trip through the fruit sections of Arkansas, Missouri, Illinois and Indiana for the purpose of making at first hand a study of the San Jose scale situation and the striking control of the scale which had been obtained by the use of lubricating-oil emulsion.

Mr. J. R. Douglass of the Bureau of Entomology, who is conducting experiments on the Mexican bean beetle at Estancia, N. Mex., reports that the beetle injury is greatest near the mountains in which the insects hibernate—the heaviest damage being caused to bean plantings opposite the mouths of canyons. From these data Mr. Douglass believes that on emerging from hibernation, the beetles follow the canyons on their way to the large valleys in which beans are grown. Flight tests are now being conducted.

Messrs. August Busck and Carl Heinrich left Washington for Amherst, Mass., on June 26, to pack the collection of Microlepidoptera formed by the late Dr. C. H. Fernald. The U. S. Department of Agriculture has recently purchased this collection from Dr. H. T. Fernald to be added to the already extensive collection of Microlepidoptera. The collection contains not only the Fernald types, but also much valuable material identified by the older microlepidopterists, and will be one of the finest additions to the collection of Lepidoptera in recent years.

Dr. M. W. Blackman, Professor of Entomology at Syracuse University, has been working since June 15 in the Division of Insects, U. S. National Museum, on the collections of bark-beetles belonging to the superfamily Scolytoidea. It is hoped that Dr. Blackman will be able to rearrange the entire collection, placing most of it in trays, and probably have an opportunity to do critical work on one or two smaller groups. He brought with him the collection of the subfamily Micracinae, which he has critically studied during the last four months.

Prof. George A. Dean of the Bureau of Entomology visited Boston July 6 for the purpose of inspecting the northern edge of the corn borer infestation in Maine and

New Hampshire. It was observed that corn was very small at that time, and because of the backward season but little evidence of infestation was found. On July 19, Prof. Dean left Washington for a visit to Manhattan, Kan. On his return trip he visited several field laboratories in the Middle West and the corn borer scouting and quarantine work in the Great Lakes region.

Mr. A. F. Satterthwait of the Webster Groves, Mo., laboratory of the Bureau of Entomology made an extended trip by auto during May in Missouri, Kansas and Nebraska. He not only had an opportunity to study the insect collections at the Universities of Missouri and Kansas, the Kansas State Agricultural College, and the Warren Knaus collection of Coleoptera at McPherson, but he also had an opportunity to do considerable collecting in the field. He was accompanied on some of the collecting trips by Dr. William Hayes, of the Kansas State Agricultural College, and Warren Knaus, of McPherson, Kansas.

A shade tree conference to consider some of the problems connected with the care and protection of shade trees was held at Stamford, Conn., August 25 and 26. The invitations to attend this conference emanated from the Tree Protection Examining Board of Connecticut, and included a small number of scientific men and a few practical tree surgeons known to be interested in the objects of the conference. Entomologists present were Dr. E. P. Felt, Albany, N. Y.; Mr. A. F. Burgess, Melrose Highlands, Mass.; W. O. Hollister, Kent, Ohio; W. O. Ellis, Boston, Mass.; Dr. Philip Garman and Dr. W. E. Britton, New Haven, Conn.

Motion pictures were taken by the U. S. Department of Agriculture under Mr. St. George's supervision, of logging operations in the woods and mill at Charleston, S. C., showing the approved methods of handling pine to prevent worm-hole injury. At Savannah and Clyo, Ga., and Vicksburg, Miss., additional motion pictures were taken illustrating methods of handling gum to prevent pinhole and wormhole injury. Several pictures were made at Vicksburg, showing methods of racking and piling lumber to prevent this character of injury. At Vicksburg extensive co-operative studies are being conducted to determine the best methods of cutting cypress to prevent borer attack.

Dr. B. A. Porter of the Vincennes, Ind., Laboratory of the Bureau of Entomology, attended a blueberry maggot conference at Bangor, Maine, on July 18. The conference was called by the National Canners Association for the benefit of the blueberry canners of Maine, to consider possible methods of preventing the presence of maggots in canned blueberries. The matter was very thoroughly discussed, but the present knowledge of the problem was not sufficient to warrant final conclusions or recommendations. The insect involved has been considered to be *Rhagoletis pomonella* Walsh, the well-known apple maggot, although the form attacking the blueberry is probably a distinct biological strain.

The Sugar Cane Insect Laboratory of the Bureau of Entomology will move on October 1st from Audubon Park, New Orleans, to Rooms 6 and 7, Wilson Building, 8200 Oak Street, New Orleans, La. T. E. Holloway and W. E. Haley are permanent employees assigned to this Laboratory, and during the fall months, L. P. O'Dowd and D. D. Ewing, Jr., will be employed as temporary assistants.

Mr. R. A. St. George of the Bureau of Entomology left Washington May 28 to conduct co-operative studies relating to the prevention and control of insects affecting crude forest products. At Portsmouth, Va., extensive studies are being conducted

to determine the effectiveness of sulphur dioxide gas, orthodichlorobenzene, and creosote in preventing and checking the attack of ambrosia beetles, or pin-hole borers, in select grades of cypress which are used for partitions in batteries furnished automobiles and airplanes. At High Point, N. C., considerable control work was done in treating infested rustic furniture with orthodichlorobenzene. About a week was spent at Asheville, N. C., with A. H. MacAndrews, who is conducting life-history studies of bark-beetles attacking pine trees, and the seasonal cutting of various trees.

The following appointments to the Bureau of Entomology have been announced: Temporary appointments: Mexican bean beetle, H. L. Weatherby, Prof. D. M. DeLong, Field Assistants; Rodney Cecil, Junior Entomologist, Norman Allen, Roy H. Stansell, Junior Entomologists, and Calvin J. Boal and Horace Richman, Field Assistants, truck crop insect investigations; John A. McLemore, Junior Entomologist, sweet potato weevil eradication; Cecil C. Wilson, Junior Entomologist, cereal and forage crop insects, Sacramento, Cal.; Hiram G. Burt, Junior Entomologist, jointworm investigations, Charlottesville, Va.; Adan Celaya, seed chalcid investigations, Yuma Valley; David Dunevan, wireworm investigations, Yakima Valley, Wash.; Wm. J. Reid, Junior Entomologist, truck crop insect investigations,Chadbourn, N.C.; Wm. M. Mingee, Junior Entomologist, sweet potato weevil eradication, Gulf Coast Region, S. F. Potts, Mexican bean beetle, Ohio.

Mr. H. R. Bryson has been appointed Assistant Entomologist in the Department of Entomology, Kansas State Agricultural College

Apicultural Notes

Mr J. E. Eckert of State College, North Carolina, was a recent visitor at the Bee Culture Laboratory.

Mr. W. J. Nolan attended the meeting of the North Carolina State Beekeepers' Association at Winston-Salem, September 10.

Mr. E. L. Sechrist was in attendance at the Maryland State Fair at Timonium in connection with the educational exhibit in beekeeping, September 1.

Professor Frances Jager of the University of Minnesota, has been selected as judge of the honey exhibit for the Mid-West Horticultural Exposition, which will be held in Waterloo, Iowa, November 11–16.

Mr. George Harrison, vocational instructor in bee culture at the University of Maryland, College Park, under Prof. E. N. Cory, has resigned and accepted a position as manager of the G. B. Lewis Company, Lynchburg, Virginia.

Gail M. Creger, a vocational student at Iowa State College, Ames, who took apiculture under Prof. F. B. Paddock, has accepted a position as manager of the G. B. Lewis Company of Wichita, Kansas.

The summer meeting of the State Beekeepers' Association of North Carolina was scheduled to be held at Winston-Salem on September 10. The secretary is J. E. Eckert, State College Station, Raleigh, N. C.

Dr. James A. Nelson, Mt. Vernon, Ohio, formerly connected with the Bee Culture Laboratory of the Bureau of Entomology, recently spent a few days at the laboratory arranging for the publication of his paper on the morphology of the honey bee larva.

Before Dr. and Mrs. Phillips left the village of Somerset, a suburb of Washington, the people of the town tendered them a farewell reception at which practically every resident was in attendance. Mrs. Phillips and the boys left for Ithaca, N. Y., on August 27, and Doctor Phillips will take up his new duties in Cornell University shortly before October 1.

Mr. E. W. Tschudi has left the Bee Culture Laboratory to return to his work at the Johns Hopkins University. Dr. Bruce Lineburg has resigned to accept the professorship in biology at Lake Forest College, and L. M. Bertholf will soon leave to attend the Johns Hopkins University. Carlton Burnside will attend the graduate school of the University of Michigan this coming winter.

Mr. Ph. J. Baldensperger, delegate from France to the International Congress at Quebec, will shortly visit various points of interest in beekeeping in the United States. Communications to him may be addressed to the Bee Culture Laboratory of the Bureau of Entomology. Mr. Baldensperger has spent many years in Palestine and other eastern countries and is an authority on eastern races of bees.

The VII International Apicultural Congress was held in Quebec September 1 to 4. Delegates were present from France, Italy, Switzerland, Belgium and Peru, as well as from various states of the United States and provinces of Canada. English and French sections were held separately and all papers presented were given at both sections. The proceedings will later be published in both languages. It was decided to leave the arrangement for the time and place of the next Congress to the permanent committee of the Congress and to make an effort to enlist the support of beekeepers from other countries in future Congresses. Following the sessions, excursions were given to various points of interest in Canada.

Mr. James I. Hambleton has been appointed Apiculturist of the Bureau of Entomology, to succeed Dr. E. F. Phillips who has resigned to accept the position of Professor of Beekeeping at Cornell University, October 1. Mr. Hambleton is a graduate of the Ohio State University, where he specialized in entomology and beekeeping. He was in four major offensives in the World War, serving through the grades from private in the hospital corps to first lieutenant in the infantry. He took a course in beekeeping at the Jardin du Luxembourg, Paris, after the signing of the armistice. He was instructor in beekeeping at the University of Wisconsin, both before and after serving in the army, and was appointed apicultural assistant in the Bureau of Entomology in 1921. He is both a practical beekeeper and a trained scientist.

At the annual summer meeting of the beekeepers of Wisconsin held this year at Fond du Lac, August 12 to 14, the beekeepers presented beautiful silver coffee services to Dr. E. F. Phillips of the Bureau of Entomology, and to Mr. George S. Demuth, Editor of *Gleanings in Bee Culture*, in appreciation of their services to Wisconsin beekeeping while they were working together in the Bureau. Mr. Demuth left the Bureau some time ago but has since then attended all the summer chautauquas arranged by the University of Wisconsin. The resignation of Doctor Phillips from the Bureau of Entomology presumably marks the close of the team work of these two men, and for that reason the beekeepers took the occasion to express their thanks in this manner. A silver vase was presented to Prof. H. F. Wilson of the University on the same occasion, in recognition of his labors for the advancement of beekeeping in the State.

Pacific Slope Notes

Professor C. W. Woodworth has returned to the University of California, having finished his work in China.

Mr. Alan P. Dodd, Entomologist of the Commonwealth Prickly-Pear Board, Brisbane, Queensland, is now in Southern California collecting insect enemies of cactus.

Dr. Frank R. Cole of Redlands, Calif., recently visited the U. S. National Museum and examined a number of species in the collection of Diptera.

The University of Southern California conferred the degree of master of science upon Mr. A. O. Larson, June, 1924. Mr. Larson presented a thesis entitled "The Host Selection Principle as Applied to *Bruchus quadrimaculatus*."

Mr. J. C. Hamlin, who was recently transferred from Southern Field Crop Insect Investigations to the Division of Stored Product Insect Investigations of the Bureau of Entomology, has just completed a survey of dried fruit insect conditions on the Pacific Coast, and had located temporarily at Dinuba, California. He will devote considerable time to the subject of vacuum fumigation for controlling dried fruit insects.

Mr. P. H. Timberlake, formerly connected with the Hawaiian Sugar Planters' Experiment Station in Honolulu, and who has resigned to accept a position with the California Citrus Experiment Station at Riverside, Calif., spent the week of June 16 to 23 in the U. S. National Museum, studying types of chalcid flies. Mr. Timberlake was on his way to visit relatives in New Hampshire, and expected to return to Riverside, Calif., where he will be permanently located, about July 15.

According to *Science*, the California Academy of Sciences is sending a collecting party from its department of entomology, in charge of Mr. E. P. Van Duzee, assisted by J. O. Martin, into the southern Arizona mountains to collect and study the Sonoran fauna of the region. They planned to leave San Francisco about July 15 and expected to remain in the field from four to six weeks, visiting the Santa Catalinas, the Huachucas and possibly others of the southern mountains.

After attending the meetings of the Pacific Slope Branch, American Association of Economic Entomologists at Stanford University, June 26 to 28, Dr. L. O. Howard spent several days in southern California, visiting both the Federal and State entomological laboratories in the vicinity. President A. F. Burgess also spent two days in a very rapid survey of the entomological work being done there, paying especial attention to the methods of biological control of citrus pests being carried out under the direction of Prof. H. S. Smith.

After a four months' leave of absence engaged in investigations on Fanning and Washington Islands, Prof. W. B. Herms has returned to active duty in the Department of Entomology and Parasitology of the University of California. On his way back from these islands, Prof. Herms stopped over at Honolulu to attend the meetings of the Pan Pacific Food Conservation Conference to which he was a delegate, returning to San Francisco via the St. Mauri August 12. While on Fanning and Washington Islands, Prof. Herms investigated certain cocoanut pests, mainly the borer, *Diocalandra taitensis* (Guerin) which is responsible for considerable damage on these islands. In addition Herms and his assistant, Mr. Harold Kirby, Jr., Fellow in Zoology, made a general study of the fauna and flora of both islands, particularly

Fanning, which is a typical coral atoll and presents a fertile field for the biologist. Extensive collections of both plants and animals were made for later studies and deposit in the interested museums of the University of California. This material is expected to arrive in San Francisco on the Motor Schooner Doris Crane about the middle of October.

Horticultural Inspection Notes

The Federal Horticultural Board has authorized the inspection and sealing of hold baggage at Honolulu for passengers traveling from Hawaii to Pacific Coast ports. This service is proving popular with the traveling public, transportation companies, and inspectors at ports of entry. It decreases to some extent the inconvenience to passengers during the rush of landing, shortens the time steamers are held in quarantine, and enables inspectors to inspect more thoroughly stateroom and other unsealed baggage.

Mr. H. F. Willard, in charge of the Bureau's laboratory at Honolulu, Hawaii, writes as follows: "Theo. L. Bissell, who has been employed at the Bureau's station at Honolulu as Plant Quarantine Inspector since January, 1921, has been granted a two-year furlough without pay to enable him to do postgraduate work in entomology at Cornell University. Alfred Lutken, a graduate of Mississippi Agricultural College, has been appointed to take Mr. Bissell's place and is now associated with Mr. Willard."

Notes on Medical Entomology

Mr. W. E. Dove, of the Dallas, Texas, Laboratory of the Bureau of Entomology, went to Jacksonville, Fla., July 21, to investigate the horse-flies in that State. Incidental to this investigation he is taking up a very interesting piece of work in collaboration with Dr. Kirby Smith of Jacksonville, on a little-known form of dermal myiasis which is present throughout the South. This malady is especially serious in parts of Florida.

Dr. H. G. Dyar of the U. S. National Museum returned July 29 from a three months' trip to the Pacific Coast, where he went in search of the larval stages of two mosquitoes, *Aedes aloponotum* and *Aedes ventrovittis*, which live in the high mountain regions. Dr. Dyar was successful in getting a large number of larvae of *aloponotum*, but did not find that stage of *ventrovittis*, although he found many adults. While in the West he visited Bakersfield, Calif., where mosquito work is being carried on by Major Charles K. Badger.

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STUDIES OF THE PARASITES OF THE ALFALFA WEEVIL* IN EUROPE

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Abstract

The following is a brief account of a study of the parasites of the alfalfa weevil, *Phytonomus posticus* (Gyll.), made in Europe by the writer between August, 1921, and August, 1923. The 14 primary parasites encountered are listed and their habits and distribution briefly considered. As a result of this work the writer has come to believe that most of the more important parasites could withstand a climate similar to that of Utah, which is in the middle of the weevil-infested territory in the United States, that the apparent effect of the parasites upon the number of weevils in Europe is not a true measure of what their effect would be in this country, and that it is advisable to attempt the colonization of the more promising ones.

Early studies of the parasites of the alfalfa weevil were made in Europe by W. F. Fiske, H. S. Smith, and W. R. Thompson in the years of 1911, 1912, and 1913. This work was discontinued in 1913 and owing to the World War was not taken up again for some years. Later, as the weevil spread to new territory in the United States, interest in the parasites again arose. By 1921, one parasite which had been introduced in the early importations had spread from the original point of introduction near Salt Lake City, Utah, until it covered practically all the weevil-infested territory in the United States and probably had become a factor in reducing the injury of the weevil. Consequently, it was thought advisable to renew the study of other parasites in Europe before further importations were attempted. It was to make these studies that the writer went to Europe in 1921.

Briefly, the main problem was to find new parasites, to establish the primary or secondary character of those involved, to determine if possible the importance of the parasites and the part they play in weevil

Phytonomous posticus (Gyll.).

control in Europe, and to select the most promising species for colonization in the United States. The immediate task was to locate the chief alfalfa tracts in France and Italy and those which could be profitably investigated from the Hyères, France, laboratory of the U. S. Bureau of Entomology. After locating these tracts, it was necessary to scout them sufficiently to determine those in which the weevil could be collected to advantage and later to select the tracts or individual fields in which parasites could be collected in numbers sufficient for study or exportation.

A survey of the southeast quarter of France, made in September, 1921, indicated that alfalfa is grown to a greater or less extent throughout most of this region. It is found along the Mediterranean coast from Marseilles to the Italian border, and along the Rhône Valley north to Lyons. Little or no alfalfa is grown for some distance northeast of Lyons in the vicinity of the city of Bourg, but farther north near Lons-le-Saunier it is cultivated and from here some distance back into the hills almost up to Champagnole. Some alfalfa is grown between Poligny and Dijon, notably in the vicinity of the villages Mont-sur-Vaudrey and Villette-lès-Dôle. It is found also extending up most of the mountain valleys east of the Rhône, and is rather common near Annecy, Chambéry, Gap, and Digne.

In our experience, weevils were most plentiful in the Rhône Valley between Valence and St. Rambert, near Lons-le-Saunier, Chambéry, Annecy, and Gap. There were several fields in or near Hyères which contained a fair number of weevils. These were watched rather closely throughout the year. The regions in which the most parasites were found were the Rhône Valley in the section just mentioned, and the Lons-le-Saunier and Chambéry sections. Many parasites were found in the Hyères section, but this probably was due to the fact that more time was spent there than elsewhere in searching for them, and because in some cases favorable conditions were provided for their accumulation.

Alfalfa tracts in Italy were fairly well known from the work of Fiske, Smith and Thompson. At that time parasites were more easily obtainable in the vicinity of Naples, Milazzo, and in the Ternese Valley, and in view of this fact no extended explorations were made elsewhere in that country. In 1922 and 1923 most of the parasitized material came from Montecorvino, south of the Bay of Naples, and from Piedimonte d'Alife, a town about 40 kilometers north of Naples in a region said by Dr. Silvestri to be much given to the cultivation of alfalfa.

Although the methods of collecting parasites were fairly simple, the parasites were so scarce that much territory and material had to be examined before they were obtained in any numbers.

Larval parasites were much easier to find than the egg parasites or the pupal parasites. The former were obtained by sweeping the weevil larvae from the fields and rearing or dissecting the parasites from them. The egg parasites were found by first dissecting the parasitic larvae from collected stems and afterward rearing them to maturity in wooden cells under direct observation in the laboratory. Only a small percentage of the early dissections showed weevil eggs, and only a small portion of the egg masses found contained parasites. In studying parasites of the prepupa and pupae, it was necessary to collect large numbers of cocoons of the host. This was done chiefly by picking up the cocoons from the stubble in newly cut fields. This work was slow and tedious at best, and owing to the fact that many hosts were removed from the field by cultural practices, parasites, and disease, before the cocoons were spun, cocoons were harder to find than any other stage, and in our experience they could be collected profitably from very few fields. The study of cocoon parasitism was especially difficult owing to the great number of primary and secondary parasites in various stages that might be found in them.

The chief parasites and some of their habits are described briefly below:

Parasites of the Eggs

Peridesmia phytonomi Gahan[1]

The larva of this pteromalid parasite feeds externally upon the eggs of *Phytonomus posticus* (Gyll.) and *Hypera punctata* (Fab.). It appears to be widely distributed in Europe and is probably the most important of all the egg parasites.

It may be found in either green or dry stems of alfalfa; when found in the latter it feeds more frequently upon the eggs of the clover-leaf weevil (*Hypera punctata*). Adults issuing from egg masses of the clover-leaf weevil are usually much larger than those from alfalfa weevil egg masses, which is probably due to the plentiful food supply. Their larvae are found feeding on egg masses in the field from January to July according to the locality, and from January to May at Hyères. Nothing is known of the number of generations since we were unable to rear the species in the laboratory or determine its life cycle by field observations.

[1]Determinations of the Chalcidoid parasites by A. B. Gahan, of the Ichneumonid parasites by R. A. Cushman.

The highest parasitism by this insect was found in a field of growing alfalfa at the edge of Hyères in January and February, 1923. This high parasitism, 10 to 30 per cent, was in part due to the fact that the alfalfa was allowed to stand untouched during the oviposition period of the weevil, which in this locality seems to lie mainly between the middle of December and the middle of February. Since the growth of the alfalfa was very slow at this time, it permitted the accumulation of a great number of eggs of the host upon which the parasite could work. Ordinarily at this time the alfalfa is closely grazed by sheep, with unfortunate results for both the host and its parasite.

We have reared this parasite from material taken at Hyères, Tournon, Evires, and near-by localities in France, and from Acerra, Portici, Montecorvino, Piedimonte d'Alife, and near-by points in Italy, and from Milazzo, Sicily. They were found near Naples, Italy, Milazzo, Sicily, and Le Luc, France, in 1913. Small numbers of predatory larvae which were not reared to maturity, some of which may represent this species, were secured from other localities in France, including Chambéry, Annecy, Champagnole, and Lons-le-Saunier.

Spintherus sp.

This pteromalid parasite proved very rare during the seasons of 1922 and 1923. Its habits, so far as known, are similar to those of *Peridesmia phytonomi*, its larvae feeding externally upon the egg masses. It seems to be the dominant species in all the higher and colder regions of France. It was taken during the years mentioned from Evires and Servoz (Higher Savoy), from Lons-le-Saunier and Champagnole (Jura), and in 1913 from Milazzo, Sicily.

Eupelminus excavatus Dalm.

The larva of this eupelmid also feeds externally upon the eggs of *Phytonomus posticus* and *Hypera punctata*. Although it was taken during the last two years only from the country around Naples, in 1913 it was found in material from Le Luc, France, and Milazzo, Sicily. Normally the larvae of this species aestivate in the stems of alfalfa and issue in the autumn. In the small amount of experimentation done in the laboratory with this insect we have not been able to breed it upon eggs of *Phytonomus*. This parasite was more common in the importations of 1913 than was *Spintherus* sp. but less so in material examined in Europe in 1922 and 1923.

Other Pteromalids

At least two other pteromalids have been obtained from alfalfa stems and in our own experience they have been associated with *Peridesmia*

phytonomi. These have been designated as Pteromalids "C" and "D." Pteromalid "D" appears to be the more common of the two in the Hyères country, and may be a primary parasite, but probably as many as one hundred predatory larvae which had been fed upon *Phytonomus* eggs in wooden cells in the laboratory failed to produce this species either as a primary or secondary parasite.

Anaphoidea luna Girault.

This mymarid is an internal parasite of the egg of *Phytonomus posticus* and *Hypera punctata*. Thus far it appears unimportant as a destroyer of eggs in green stems, but in dry stems it is much more effective. This is probably because the parasite can enter the dry stems and place eggs in the greater part of the host eggs, whereas in green stems it can only oviposit in one or two of the eggs next the egg puncture of the host. It oviposits to an equal extent in the eggs of *H. punctata* and very often, probably most of the time, places two eggs in each egg of the clover-leaf weevil, whereas in the egg of the alfalfa weevil only one is inserted. The parasites from eggs of the clover-leaf weevil are considerably larger than those from the alfalfa weevil, whether one or two come from a single egg. This insect breeds quite readily in confinement. We have taken it from the environs of Hyères, France; Naples, Italy, and Milazzo, Sicily.

Parasites of the Larvae

Bathyplectes curculionis (Thoms.)

This internal parasite of the larva breeds freely in the laboratory on all sizes of larvae and is the chief parasite which has been colonized in Utah. It appears to be generally distributed over Europe where the weevil occurs. We have taken it from Lons-le-Saunier, Annecy, Chambéry, Gap, Valence, Digne, Blois, Aix-en-Provence, and Hyères, all in France, and from Bevagna, Acerra, Portici, Piedimonte d'Alife, and other places in Italy, and from Sicily. It is probably the most important of the larval parasites in Europe. Occasionally and locally parasitism by another parasite may exceed that by *Bathyplectes curculionis*, but the average parasitism over large areas has always been highest for this species. It is itself parasitized by many species, chief among which are *Mesochorus nigripes* Ratz. and *Gelis stevenii* (Grav.)

Bathyplectes corvina (Thoms.)

This parasite of the larva is similar in habits to *Bathyplectes curculionis*, but it has only one generation a year. It is much more difficult to handle in the laboratory than *B. curculionis* because most of the insects die within their cocoons when kept in confinement. Whereas

Bathyplectes curculionis passes the winter as a larva within its cocoon, most of the individuals of *B. corvina* pupate in the fall and pass the winter in that stage or as adults inside the cocoons, unless they have been kept in cold storage throughout the summer and winter; in the latter case most of them remain as larvae. In field-collected cocoons kept in the Hyères laboratory in the summer of 1922, many perfectly formed adults were found in the fall but there were no issuances from the cocoons until spring. Although in general this species seems less important than *B. curculionis*, it appeared to be the dominant species in some localities in 1922 and 1923. This was true of the Hyères section. We have found *B. corvina* in practically all the regions in which we recovered *B. curculionis.*

This parasite also is parasitized by many other insects, chief among which is *Mesochorus nigripes*, as in the case of *B. curculionis*.

Bathyplectes tristis (Grav.)

This species is an internal parasite of the larvae of *Phytonomus posticus* and *Hypera punctata*. We found it very scarce in our material collected in 1922 and 1923. There is probably one generation a year. This insect is parasitized by other species, chief among which is *Mesochorus nigripes*. The writer has reared what is believed to be *Bathyplectes tristis* from an undetermined weevil collected from wild alfalfa at Hyères, France.

Tetrastichus incertus (Ratz,)

This eulophid parasite of the larva was collected chiefly in 1922, from the neighborhood of Piedimonte d'Alife, Italy. Of 6,647 larvae from this region, 4,737, or 71.2 per cent, were parasitized by it. Dissected larvae were found to contain from 6 to 17 parasite larvae each. It was proven to be a primary parasite by breeding it upon nonparasitized laboratory-hatched weevil larvae. A small number of these eulophids in prepupal larvae were found to be parasitized externally by a eupelmid parasite, *Eupelmus atropurpureus* Dalm.

This parasite was found in small numbers in material from Switzerland in 1913, and we took a few from material from Montmélian, France, in 1923.

Parasites of the Prepupae and Pupae

Dibrachoides dynastes (Först.)

This external parasite of the prepupae and pupae of the weevil was bred upon nonparasitized prepupae and pupae by T. H. Parks, E. J. Vosler, P. H. Timberlake, and the writer. While in general it seems to prefer prepupal hosts, it will at times breed just as readily upon the

pupae. From one to six parasites have been reared to maturity upon a single host. This is probably the most important of the prepupal and pupal parasites in Europe, but owing to the variability in effectiveness of different parasites from year to year, it is difficult to make sure of this. It was taken in 1922 and 1923 from Hyères, Tournon, and Lons-le-Saunier, in France, and from points around Naples, in Italy. It is parasitized to a small extent by a eulophid, *Pleurotropis* sp., which in the laboratory oviposits in the pupae of *D. dynastes* but not in the larvae.

Necremnus Leucarthros (Nees)

We have reared and bred upon *Phytonomus* prepupae a eulophid parasite which appears to be *Necremnus leucarthros* (Nees). On Phytonomus hosts, the habits of the insect are similar to those of *Dibrachoides dynastes*. In the laboratory as many as 41 eggs have been laid upon a single host but only a few of these matured. As many as 18 well developed adults have been secured from a single prepupa. No secondary parasites have been reared from it. The species was taken from material from the country near Naples in Italy and from Tournon and the high regions about Chambéry in France.

Parasites of the Subfamily Cryptinae

The recorded parasites belonging to the subfamily Cryptinae, *Aenoplegimorpha micator* (Grav.), *Hemiteles graculus* (Grav.), and *Spilocryptus pumilis* Kriechb., have not proven very important in our experience. In Europe in 1923, when most of the parasites of the subfamily Cryptinae were found, *H. graculus* and an undetermined parasite belonging to the tribe Gelini were the only members of the subfamily Cryptinae which were found in any considerable numbers. *H. graculus* was more common in Italian material in 1923 than in 1913, but even then rare. In our experience *H. graculus* bred freely in the laboratory and was reared from egg to adult in 15 days in June. In addition to the parasites of this subfamily mentioned above two other species have been found in cocoon material but it has not been proven whether they are primary or secondary. These are *Spilocryptus* sp. and *Hemiteles* sp.

Practically all the parasites belonging to the subfamily Cryptinae studied in 1922 and 1923 came from Italy near Naples.

Itoplectis maculator (Fab.)

This is an internal ichneumonine parasite of the prepupae and pupae of *Phytonomus*. The writer has been able to obtain only a few undersized specimens of the species by breeding in the laboratory, but it undoubted-

ly can act as a primary parasite on *Phytonomus*. In the laboratory most of the hosts were so thoroughly stung by the female that they died before the parasites developed. Hosts, similar in appearance to those killed in this way in the laboratory, have been collected in the field. A few eggs and larvae have been dissected from hosts apparently in all other ways healthful. We have reared from a small number of *Phytonomus* pupae a black pteromalid, *Catolaccus ater* Ratz., which probably had parasitized *Itoplectis maculator*.

We have taken this insect from Hyères, Tournon, and Lons-le-Saunier, France, and Piedimonte d'Alife and Naples, Italy.

Distribution of Parasites in Southern Europe

As is well known, one larval parasite among the list given, *Bathyplectes curculionis* (Thoms.), is well established in the weevil-infested territory in the United States, and parasitism by it there exceeds any of which we have record in the Old World. The question naturally arises whether or not some of the other parasites in the list which may appear more or less obscure in their present environment may not be able to increase in importance after colonization in this country. As our investigations have shown quite clearly, we believe, that the agricultural systems there prevailing have much to do with the relative scarcity of the weevil in Europe, we would like to know what the effect of other introduced weevil parasites will be if they can be colonized in Utah and near-by states where cultural systems have apparently failed to hold the weevil in check.

Among the most promising of the parasites studied in Europe are the egg parasites *Peridesmia phytonomi*, *Spintherus* sp., and *Anaphoidea luna;* the larval parasites *Bathyplectes corvina* and *Tetrastichus incertus;* and the pupal parasites *Dibrachoides dynastes* and *Necremnus leucarthros.* Of special significance, however, from the standpoint of their possible introduction into the United States is the distribution of these parasites, for some of them have been thought to be southern insects probably incapable of existing in a climate similar to that of Utah.

It will be remembered that *Peridesmia phytonomi* was found, among other places, at Hyères and Evires. Hyères is the most southerly point in the French Riviera. Frost rarely occurs there and alfalfa grows practically throughout the year when sufficient moisture is available. Date palms, figs, and mandarins also are grown there. Evires, on the other hand, is a village in Higher Savoy with an altitiude of about 2,500 feet and with short summers and long winters. It is in one of the

coldest and highest sections in that region in which alfalfa can be grown.

Spintherus sp. was found at Milazzo, Sicily, in 1913, and at Servoz, Lons-le-Saunier, and Champagnole, France, in 1922 and 1923. Milazzo has a warm climate. West of Milazzo along the north coast of Sicily much of the land is given to the cultivation of citrus fruits. Champagnole represents the highest and coldest section in that general locality in which alfalfa can be grown. It is at an altitude of about 1,800 feet. Servoz is in Higher Savoy, near Chamonix, at the foot of Mont Blanc, and has an altitude of about 2,700 feet. This also is about the highest and coldest section in which alfalfa is grown there. It should be remembered in this connection that *Spintherus* sp. appears to be the dominant species in the cold country, though, as stated, *Peridesmia phytonomi* also occurs.

Anaphoidea luna seems to be more restricted in range than either of the preceding, but is important on account of its work in dry stems.

Both of the larval parasites *Bathyplectes corvina* and *Tetrastichus incertus* have a considerable range. *Bathyplectes corvina* was found practically wherever the alfalfa weevil occurred and seems to be the dominant species in some regions. *Tetrastichus incertus* was not found as commonly as *Bathyplectes corvina*, but it occurred in Switzerland outside Zurich in 1913, at Piedimonte d'Alife, Italy, in 1922 and 1923, and near Montmélian in Savoy, France, in 1923. One of the most significant facts about *T. incertus* is the extent to which it parasitized the alfalfa weevil larvae in Piedimonte d'Alife, Italy, in 1922. This parasitism, 71.2 per cent, exceeds that of any other insect parasite of the alfalfa weevil we have found in Europe and serves to show how important a seemingly inconspicuous parasite may become when the proper conditions are present.

Dibrachoides dynastes was found at Hyères, at Tournon (near Valence in the Rhône Valley), and at Lons-le-Saunier, France, and at Naples, Italy. Lons-le-Saunier is near Champagnole but at a lower altitude. *Necremnus leucarthros* has been taken from the country near Naples, Italy, and from Tournon and the high regions about Chambéry, France.

Summary and Conclusions

The alfalfa weevil is controlled to a large extent in Europe by cultural practices and climatic conditions, but wherever it occurs it is parasitized to a greater or less extent by insects. The parasites considered most important during the two years spent by the writer in France were the egg parasites *Peridesmia phytonomi*, *Spintherus* sp.,

and *Anaphoidea luna;* the larval parasites, *Bathyplectes curculionis*, *Bathyplectes corvina*, and *Tetrastichus incertus;* and the prepupal and pupal parasites, *Dibrachoides dynastes* and *Necremnus leucarthros*.

With the exception of *Anaphoidea luna*, all these parasites were shown to be able to live under a rather large range of climatic conditions. In view of this fact, it seems probable that most of them could survive a climate like that of Utah, and leaving out of consideration the possible need of undiscovered alternate hosts for some of them to complete their life cycle, it seems practicable to colonize all of them. There is a considerable difference in the extent of parasitism by these species in different seasons and sections, and in different fields in the same section, doubtless owing in part to the effect of climate, cultural systems, and disease upon the numbers of the host. Neither cultural systems nor diseases appear to check the alfalfa weevil in the United States to as great an extent as in Europe. The greater numbers of weevils present, therefore, may afford a better opportunity for the work and multiplication of parasites and increase their effectiveness, as seems to have been the case with *Bathyplectes curculionis*.

THE POSSIBILITIES OF WEEVIL DEVELOPMENT IN NEGLECTED SEEDS IN WAREHOUSES*

By A. O. LARSON, *Associate Entomologist*, and C. K. FISHER, *Junior Entomologist*, *Stored Product Insect Inevstigations, Bureau of Entomology, U. S. Department of Agriculture*

ABSTRACT

Bean growers as well as commercial bean warehouses usually keep lots of beans and cowpeas over the summer. Such lots of seeds furnish ideal breeding places for the common bean weevil, *Bruchus obtectus*, and for the four-spotted cowpea weevil, *B. quadrimaculatus*. They frequently become weevily and furnish the chief source of weevil infestation for the growing crop. Heavy infestations in the field have been traced directly to small lots of weevily seeds.

The experiments here recorded show that several broods of weevils may develop in a small lot of seeds. Most of the weevils fly away in search of new material on which to oviposit, but enough remain among the original seeds to keep up the infestation until practically all the available food has been removed. Sixty-nine pounds of black-eyed cowpeas produced approximately 368,000 emerged weevils or 4½ adults for each seed, and were reduced 62 per cent in weight.

Bean growers frequently have small lots of beans of one or more varieties left over after the spring planting is completed. Because they

*In this article any storehouse about the farm is considered a warehouse as well as all commercial bean warehouses.

are only small quantities, they are not marketed but are stored to be used for seed the next year or to be mixed with the new crop and sold. Bean screenings and other small lots of beans may also be kept over the summer in some of the out-buildings about the farm. These beans frequently become weevily and are overlooked until they are practically ruined. Even in large commercial bean warehouses lots of weevil infested beans are held during the summer. Such infested seeds furnish the chief source of weevil infestation for the growing crop. They not only become unmarketable but they furnish material in which weevils are able to continue their development throughout the summer.

In order to determine the potential possibilities for infesting a new crop, by securing information bearing on the approximate number of weevils which may emerge in storage and the time these weevils would fly from storage in search of new beans upon which to oviposit, as well as the duration of such infestations under conditions comparable to those obtaining in barns or other out-buildings on farms of Southern California, the writers infested a part of a bag of black-eyed cowpeas with the four-spotted cowpea weevil, *Bruchus quadrimaculatus*.

On July 13, 1923, 25 pairs of *B. quadrimaculatus* were placed in an ordinary bean sack containing 69 pounds of "choice recleaned" black-eyed cowpeas. The bag was placed on a table inside of an insect cage built for this purpose. The cage was 8 x 6 feet and 6 feet high with a narrow door in one end. The top was covered with muslin. An 18 inch strip of 16 mesh wire screen was placed around the entire upper and lower part of the cage; a 38-inch strip of muslin placed around the middle of the cage allowing an inch to lap over the upper and lower wire strips completed the covering. The screen wire and cloth were fastened securely with cleats at the edges. The door was covered with screen. This cage was thought to furnish conditions quite similar to those in many of the out-buildings and sheds in which left over bags of beans are stored in California. The out-door temperature was recorded in a screened insectary adjoining the cage on the south side; the daily means are recorded in Chart I. During the summer a piece of compo board was laid over the sack but later a window was put over it to keep off the rain.

Throughout the experiment the weevils were counted as they were caught in small glass vials containing kerosene. Weevils at large in the cage were recorded daily for the most part. It will be appreciated that the date of capture indicates only the time when the weevils left the

sack of cowpeas in search of new material upon which to oviposit, and not necessarily the actual date of emergence in the sack.

Daily examination indicated that the original 25 pairs of weevils showed little inclination to search for a new supply of food in which to breed. Only 5 specimens, 3 males and 2 females, were found on the walls of the cage. The last living adult was noted on July 27th.

Adults of the first brood were noted first on August 9th, when one weevil was found on the walls of the cage. The peak of emergence of this brood occurred between August 20 and 25th. During this time approximately 1,600 weevils were caught about the cage. Practically all of these weevils remained inside of the cage because most of them were too large to go through the interstices of the 16 mesh screen. Apparently a large proportion of the females of the first brood laid eggs before leaving the infested bag of seeds in search for new material.

The daily catch of weevils became smaller and smaller until only 15 were taken on September 5th. After that date the numbers again began to increase indicating that a second brood was emerging.

The flight peak of the second brood was reached between September 18 and October 2. During this period 54,138 weevils were recorded, 1,528 of which were caught on the outside of the cage. Eggs distributed on ripening pods in the garden nearby, indicated that a large number of weevils had escaped.

Larson and Simmons[1] pointed out the fact that a heavy infestation of weevil may raise the temperature of the cowpeas within a bag 35°F. above the surrounding room temperature. During the period of heavy emergence, between September 18 to October 2, the temperature of the cowpeas remained near 100°F. both day and night. This high temperature appeared to cause the emerging weevils to leave the bag, soon after emerging. This was especially noticeable during warm mornings and continued until the atmosphere began to cool. As night approached with its marked and rapid lowering of temperature all weevils about the cage sought the warm shelter of the bag of cowpeas. This became more marked as winter advanced with its warm or hot days and its cool or cold nights.

The third brood of weevils appeared to reach its maximum during the latter part of October. The weevils of this brood were noticeably smaller than those of the earlier broods, consequently a larger percentage of them escaped through the screen wire of the cage.

[1]Insecticidal Effect of Cold Storage on Bean Weevils, Journal of Agricultural Research. Vol. XXVII, No. 2, January 12, 1924.

In addition to the mean daily temperature, Fig. 18 records the number of weevils emerging during five day periods from August 9, 1923, to March 14, 1924, the dates of the first and last catch respectively. These

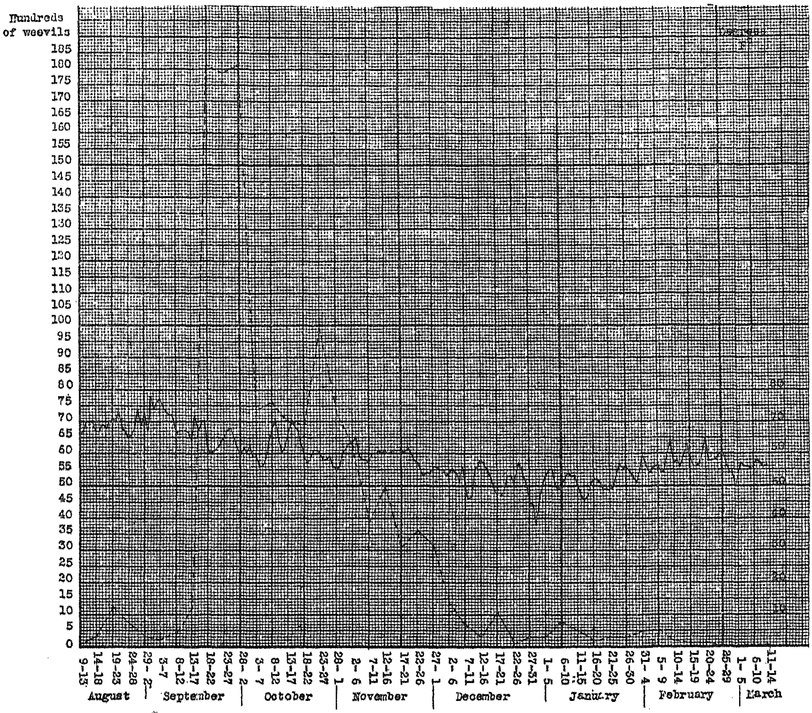

Fig. 18.—Record (broken line) of the number of Bruchids captured during five-day periods between August 9, 1923, and March 14, 1924. Daily mean temperatures for periods shown by solid line.

periods do not necessarily correspond with the dates during which the peak flights occurred as the peak flights could have been on the last two days of one period and on the first three of the next or vice versa. The chart shows distinctly the flight periods of the first, second and third broods. It was thought that after the majority of the third brood emerged there would be such an overlapping of generations that it would be impossible to determine when the third ended and the fourth began or when any later brood began. As a matter of fact, after the third brood had emerged there was left in the seeds so little food that the lack of food alone would have greatly retarded successive weevil de-

velopment, even had unfavorable winter weather not intervened. This absence of food prevented later heavy infestations.

From the 69 pounds of black-eyed cowpeas (original weight) 137,233 emerged weevils were recorded as having been caught about the cage. At the end of the experiment the dead weevils loose among the seeds in the bag were measured; from an actual count of a smaller measured lot the total number of adult weevils that had emerged and died within the sack was estimated at 56,100. This makes a total of 193,333 adult weevils that were recorded.

At the close of the experiment the 69 pounds of cowpeas had been reduced to 26¼ pounds, a loss of about 62 per cent. There was also 15 ounces of frass scattered free within the bag.

It required 3,150 of these weevil eaten cowpeas to make a pound, therefore, 82,687 cowpeas were contained in the 26¼ pounds within the bag. This would indicate that at least 2-⅓ weevils had emerged from each cowpea. A count of the emergence holes showed that 445 weevils or about 4-½ per seed had emerged from 100 cowpeas. On this basis it would appear that 367,957 weevils had emerged, of which 174,624 had escaped unrecorded. It was known that after the first generation, large numbers were escaping. Thousands of weevils were also lost in the loose dirt on which the cagewas standing, so it is believed that an estimate of 4.45 weevils per cowpea is not too high an estimate of the number produced.

That practically all of the food material was eaten out of the cowpea was shown when a number of the cowpeas were dissected. It was impossible to determine the number of dead larvae that were contained within the seeds because the small larvae after drying could not be separated from the frass within the cowpeas. The dissection of 100 cowpeas showed 138 dead pupae and adults which apparently had starved to death before becoming fully developed. On that basis 114,108 pupae and adults had died within the seeds. It is probable that several times as many young larvae died for want of food.

Several undetermined species of spiders lived about the cage and preyed to some extent on the weevils. Only 210 adults were recorded as having been killed by spiders.

Observations in the field indicate that weevily beans and cowpeas left neglected about storage places are practically the only source of infestation for growing crops.

While inspecting lots of beans as they were being delivered to a warehouse at Puente, California, the senior writer came across a lot of weevily

black-eyed cowpeas which had been grown at Spadra, a section which had previously been free from weevils. There were only a few bean growers in Spadra but that year, 1922, they all produced weevily beans. Investigation showed that one grower after completing his planting in the spring had left his bean planter about half full of black-eyed cowpeas. These cowpeas had been purchased at a warehouse where some seeds were badly infested with *Bruchus quadrimaculatus*. The seed although showing no weevils at planting time must have contained some undeveloped weevils because those in the bean planter when found in August were heavily infested. In this instance a few neglected cowpeas were the direct cause of a serious loss not only to the owner of the neglected seeds but to his neighbors as well.

Other instances where badly infested crops could be traced directly to neglected lots of seeds have come under the writers' observations at Puente, Chino, and Modesto, California.

Weevily lots of beans and cowpeas should be fumigated or heated to kill the weevils, and should then be fed to hogs or poultry or should be destroyed. All lots of beans and cowpeas should be examined frequently to insure against an outbreak of weevils.

A SUPPOSEDLY BENEFICIAL INSECT DISCOVERED TO BE A CITRUS PEST

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Abstract

Holcocera iceryaeella Riley which was formerly recorded as a scale predator and scavenger is found also to be a secondary feeder on oranges, causing damage similar to that of *Tortrix citrana* Fer.

During our investigation of the Orange Tortrix the larva of another species of moth has been found doing damage to oranges similar to that of *Tortrix citrana* Fer. Specimens of this moth were sent to Mr. August Busck, specialist in Lepidoptera, United States Department of Agriculture, Bureau of Entomology and he determined them as *Holcocera iceryaeella* Riley. He expressed surprise that this insect should be found injurious to oranges and stated in his correspondence as follows:

"This species (*Holcocera iceryaeella* Riley) is supposed to be actually predaceous on the scale insects and hence a beneficial insect. The entire genus is composed of species more or less scavenger or secondary feeders."

This moth was first taken in 1886 in the vicinity of Los Angeles by Albert Koebele who was then a special agent for the United States De-

partment of Agriculture working on methods for the control of the cottony cushion scale. He sent specimens to C. V. Riley (1), Chief of the Bureau of Entomology, who described them in the same year as *Holcocera iceryaeella*. Koebele reported the larvae as feeding on living black scale and on dead cottony cushion scale. The next account we have of this insect is in 1916 in a short paper by E. O. Essig (2) entitled "A Coccid Feeding Moth." Essig records it as occurring on the campus of the University of California in Berkeley and finding it most abundantly on a sweet bay tree, *Laurus nobilis* Linn., which was severely infested with the greedy scale, *Aspidiotus camelliae* Sign. He lists as hosts in addition to the black scale, *Saissetia oleae* (Bern) and the cottony cushion scale, *Icerya purchasi* Mask., the following: European peach scale, *Lecanium persicae* (Fab.), the greedy scale, *Aspidiotus camelliae* Sign., and Baker's mealybug, *Pseudococcus bakeri* Essig. It is also recorded by Horton (3) in 1918 as a mealybug predator.

The larvae when full grown are 7 to 9 mm. in length. They are brownish gray with longitudinal stripes of a lighter color and have a brown to shiny black head and prothoracic plate. In habits they are moderately irritable and occupy nests made by webbing together bits of trash such as old blossoms that have fallen and collected on a leaf. Or they may occupy an old curled leaf or an abandoned Tortrix nest. Often they locate between oranges where they make a nest and feed on the fruits.

The adult is a small gray moth from 6 to 8 mm. long with a wing expanse of about 15 mm. When at rest the wings are folded straight back giving the moth a linear appearance, being only a little wider toward the posterior end than at the head. Across each forewing there is an oblique line of a lighter color. These lines form a V-shaped mark on the back when the wings are folded.

The forewings are fringed on the tip and outer half of the hind margin. The hind wings are fringed clear around but the fringe on the hind margin is extra long.

The pupae are scarcely 5 mm. long and are like small dark brown grains of wheat with the abdominal segments quite closely compressed. They are found within the larval nests.

The injury to the fruit is similar to the work of *Tortrix citrana* but the holes and channels into the orange are, as a rule, not quite so deep and pronounced. I have repeatedly taken these larvae from nests on oranges and found the fruit damaged beneath and on several occasions have taken full-grown larvae from their tunnels where they had bored

out of sight under the orange peel. As a further test I placed some larvae in small individual cages on oranges hanging on the trees and found that most of the larvae fed on the fruits.

These moths occur in Orange and Los Angeles Counties together with *Tortrix citrana* Fer. There are some *Holcocera* present in practically all orange groves but the trees that are dirty because of scale insects are apparently more heavily infested. In Orange County, at present, there are more *Holcocera* than *Tortrix*.

This is not a new insect as we learn by its history but it seems to have digressed from its original habits of scavenger and predator on scale insects to a secondary feeder on oranges where it occurs in the citrus districts. *Tortrix citrana* and *Platynota tinctana* Walker have received the blame for the wormy oranges in Southern California but I am sure that *Holcocera iceryaeella* has been responsible for some of the damaged fruits, perhaps for most of the wormy oranges that formerly were supposed to have been caused by *Platynota tinctana* Walker, which I have found too sparingly in the citrus areas of Los Angeles and Orange Counties during the past year to even cause a noticeable amount of wormy fruit.

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CAUSES OF FLUCTUATION IN NUMBERS OF BEET LEAFHOPPERS (*EUTETTIX TENELLA* BAKER) IN A NATURAL BREEDING AREA OF THE SAN JOAQUIN VALLEY IN CALIFORNIA

By Henry H. P. Severin, Ph.D., *California Agricultural Experiment Station*

Abstract

The primary cause for the enormous increase of the beet leafhoppers during 1919, hinges on two factors: (1) there were no summer migrations of the pest during 1918, so that a large number of eggs were deposited during the autumn; (2) the nymphs which hatched from these eggs found an abundance of green food not only in the cultivated areas but also on the plains and foothills after the heavy September rains germinated the seeds of the vegetation.

The factors associated with the reduction in numbers of the beet leafhoppers vary in different years. The primary cause for the enormous reduction in numbers of the spring brood hoppers on the plains and foothills during 1923, was due to the early drying of the pasture vegetation during March instead of April and May as in previous years from 1919 to 1922. Secondary factors which reduce the number of leafhoppers in a natural breeding ground are natural enemies, spring and summer migrations, fungus diseases and rainfall.

Periodical Outbreaks

According to Ball (1) the periodical outbreaks of the beet leafhopper west of the Rocky Mountains occurred during 1899–1900, 1905, either 1914 or 1915, and east of the Rockies in 1903 and 1908.

In California the most reliable records of the outbreaks of curly leaf date back to 1899 at King City in the Salinas Valley. The periodicity of the beet leafhopper and the interval between outbreaks may be shown as follows:

1899–1900, 1905, 1913–1914, 1918–1919–1920–1921–1922
4 7 3 years.

It is evident that, with the exception of 1905, the outbreaks of the beet leafhopper occurred twice in two successive years and once in five consecutive years. An examination of the number of acres planted, the acreage abandoned, and the tonnages harvested indicates that when blight occurs in two successive years, the drop in tonnage due to the disease is greater in the second year. During the years 1918 to 1922, curly leaf caused greater losses during 1919 and 1921, than in 1918, 1920 and 1922, when the acres abandoned are taken into consideration. The largest losses were sustained during the second year in 1919.

Factors Favorable for Increase of Beet Leafhoppers

What are the factors associated with the severe outbreak of the beet leafhopper during the second year? On September 11 to 13, 1918, heavy rains fell in the San Joaquin and Salinas Valleys, germinating the seeds of the pasture vegetation on the plains and foothills, and a new growth of weeds developed in the cultivated areas. During the autumn the salt-bushes and other favorable host plants of the leafhopper normally become dry and the nymphs which hatched from eggs deposited in the fall by the females of the summer broods now found an abundance of food in this new growth of vegetation in the cultivated territories. These nymphs acquired the winged stage subsequent to October and November after the return flight of the dark winter adults to the plains and foothills. During the winter these stragglers which remained behind in the cultivated districts congregated on the very earliest planted beets in the northern part of the San Joaquin Valley and one-half of the 1919 crop showed curly leaf symptoms before the enormous numbers of pale green leafhoppers of the spring brood flew from the plains and foothills into the cultivated regions during April. According to Mr. W. W. Thomas, over one-half of the beet crop was blighted at King City (Ranch 3) by

the overwintering brood before the spring generation invaded the beet fields.

The writer (3) has published the fact that nymphs were also taken during November and December, 1918, on Red Stem Filaree (*Erodium cicutarium*) growing on the foothills of the San Joaquin and Salinas Valleys. These nymphs hatched from eggs deposited in Red Stem Filaree by the summer brood females and not by the dark overwintering forms.

The Weather Bureau reports for Stockton, situated in the northern part of The San Joaquin Valley, show that there were only five years in which the September rainfall was more than one inch during the past 74 years, as follows: 1894—1.76; 1899—3.59; 1904—2.27; 1912—1.39; and 1918—3.68 inches. It is evident that heavy September rains fell during 1899, 1904 and 1918, and were followed in the next year by severe outbreaks of curly leaf. The year 1913 is the only exception in which a trace of rainfall recorded for September and October was followed by serious damage from curly leaf during the following year 1914, but September rains recorded for 1912 preceded the outbreak of blight in 1913. In the Salinas Valley an abundance of rain fell at King City during the autumns of 1913 and 1918, preceding the serious outbreaks of curly leaf during 1914 and 1919.

On the other hand, when no large amount of green vegetation is available in the cultivated areas during a dry autumn, the number of stragglers is greatly reduced and a low percentage of curly leaf occurs in early planted beet fields during the winter. During September, 1917, .14 inches of rain fell at Manteca, and 4 per cent of the early planted crop was affected with curly leaf in the northern part of the San Joaquin Valley before the pale green adults of the spring brood flew into the beet fields during April, 1918. Again in 1919, .49 inch of rain fell in September, and about one beet in a thousand showed the disease symptoms before the pest invaded the beet fields during April, 1920. No rains fell during September, 1920, and an average of 5 per cent of the early planted beets were blighted before the spring dispersal of the first brood from the plains and foothills into the cultivated areas occurred in April, 1921.

Although the dark winter brood adults which remained behind in the cultivated areas caused curly leaf in half of the crop of the earliest planted beets in 1919, nevertheless, the most serious factor associated with the severe outbreak of the disease is the enormous hordes of pale green leafhoppers which invaded the beet fields during April. Al-

though it is commonly supposed by agriculturists and fieldmen that a good crop can be obtained when the foliage of sugar beets covers the rows or shades the ground by the time that the adults of the spring brood fly into the beet fields, the writer is fully convinced after the outbreak of curly leaf in 1919 that such is not always the case.

The primary cause for the enormous increase in numbers of the beet leafhoppers during 1919 hinges on two factors: (1) there were no summer migrations of the pest during 1918, so that a large number of eggs were deposited during the autumn; (2) the nymphs which hatched from these eggs found an abundance of green food not only in the cultivated areas but also on the plains and foothills after the heavy September rains germinated the seeds of the vegetation.

Factors Concerned with the Reduction in Numbers of Beet Leafhoppers

Early Drying of Pasture Vegetation.—It was frequently observed in the San Joaquin Valley that heavy north winds dry the pasture vegetation rapidly on the plains and foothills during April and May. In all probability, when the pasture vegetation becomes wilted and begins to dry, large numbers of eggs of the beet leafhoppers fail to hatch, as is the case when Red Stem Filaree, weeds and sugar beet leaves wilt and become dry in the greenhouse.

An examination of the climatological data of the Weather Bureau Office during 1923 shows that February was the driest in 11 years and the driest March in 27 years in California. Drought conditions continued for a period of six consecutive weeks, from the middle of February to the close of March. Desiccating northerly winds prevailed during March.

The primary cause for the enormous reduction in numbers of the spring brood leafhoppers on the plains and foothills during 1923 was due to the early drying of the pasture vegetation during March instead of April and May as in previous years from 1918 to 1922. Mr. E. A. Schwing, Entomologist for the Spreckels Sugar Company Agricultural Experiment Station, reports that the plains and foothills of the southern and middle sections of the San Joaquin Valley were almost entirely free from hoppers except on the floor of Little Panoche Valley, where such nymphs as did hatch were forced to congregate on green pasture vegetation growing in the drainage furrows. Records taken in previous years in Little Panoche Valley showed that the nymphs and adults assemble on green pasture vegetation in the drainage furrows during April and May.

NATURAL ENEMIES.—There are several secondary factors which reduce the number of beet leafhoppers in a natural breeding area. In all probability, the most important of these are the natural enemies of the leafhopper, a subject which has already been discussed in a previous paper (6). No information is at hand as to the value of egg parasites on the plains and foothills, and until more is known concerning these beneficial insects, Hartung (2) is hardly justified in stating that the problem of periodicity is associated with the fluctuation in the number of egg parasites.

SPRING MIGRATIONS.—Spring migrations reduce the number of beet leafhoppers in a natural breeding area.

SUMMER MIGRATIONS.—Summer migrations may deplete to a large extent the natural breeding grounds of the beet leafhopper; the nymphs and adults which remain behind are then hard-pressed by parasites and predaceous enemies. The observations on the summer migrations from the San Joaquin Valley during 1919 have not been published and the details follow.

A trip was taken to the southern part of the San Joaquin Valley on July 24 to 25, with Mr. J. W. Hartung, and it was found that a summer migration of the pest had occurred. In the Connor and Corcoran beet districts the sugar beets not harvested were mostly dead owing to curly leaf, but the adults were scarce on the green innermost leaves with dried outer foliage of such beets as could be found. Sweepings were made on some of the most favorable host plants, such as the saltbushes growing in and along the margin of beet fields, but the leafhoppers had not assembled on these plants. During April and May, thousands and thousands of hoppers were found on various species of Atriplex, but in July it was difficult to secure 100 adults on these same plants to determine the percentage of parasitism.

In the middle portion of the valley the beet leafhoppers were extremely abundant on Russian Thistles and various saltbushes during the spring, but on July 26, the adults were rare on these plants growing in irrigated fields. Along the roadsides and in the fields that had not been irrigated the Russian Thistles attained a few inches of growth and died, owing to a shortage of rain and probably also to the drain of enormous hordes of bugs.

In the northern section of the San Joaquin Valley enormous numbers of adults had congregated on June 26, on Bractscale (*Atriplex bracteosa*) growing among blighted sugar beets in the vicinity of Hatch Station. The foliage of these saltbushes was covered with droplets of clear

excrement which glistened in the sunshine. When a person walked past one of the weeds, so that a shadow was thrown on the plant, a swarm of hoppers flew up. Nymphs were still abundant on sugar beets with green innermost leaves and dried outer foliage. Our next visit to these beet fields on July 5 showed that most of the insects had left saltbushes and that a summer migration had occurred. Another assemblage of the leafhoppers was observed on Bractscale on July 26.

Fungus Diseases.—In years with an abundance of rainfall fungus diseases may play an important rôle in the reduction in numbers of the pest in certain parts of a natural breeding ground, such as the northern part of the San Joaquin Valley (4). It was found, however, in the fog belt of two counties that the beet leafhopper succumbed to a fungus disease during the dry season (5).

Rainfall.—The writer (3) has published the fact that heavy rainfall kills some of the beet leafhoppers, but in all probability, is a minor factor in the reduction of the number of adults.

Predicting Outbreaks

According to Ball (1) "any information by which the probable occurrence of these periodic outbreaks could be foretold would, therefore, be worth millions of dollars to this industry. It is probably more important to be able to say that there will be no flights to a given region during a season than to predict the probability of such occurrence."

It is evident that accurate predictions can be made in the reduction in numbers of the spring brood beet leafhoppers in a natural breeding area with the early drying up of the pasture vegetation. This prediction can be made safely during March. This information, however, is of no practical value in the interior regions of California, where early planting should be practiced. In the fog belt, where late planting should be practiced, the information may be of practical importance.

If the factors associated with an increase of the beet leafhopper were accurately determined, the prediction of an outbreak of the pest could not be made until after the spring brood hoppers appear on the plains and foothills. The prediction can be made safely during April, in natural breeding grounds, but in the interior regions of California the beets would have been planted previous to the spring dispersal, if early planting was practiced. The information in regard to the presence of large numbers of hoppers on the plains and foothills would be of no accurate value in the fog belt, for the insects will not invade the coast regions, if fogs are present at the time that the spring flights occur, but will enter this area when fogs are absent.

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INJURIES TO PEPPERS IN CALIFORNIA BY *ANTHONOMUS EUGENII* CANO

By ROY E. CAMPBELL, *Associate Entomologist, U. S. Bureau of Entomology, Alhambra, California*

ABSTRACT

During 1923 the pepper weevil (*Anthonomus eugenii*) was found to be present in several pepper fields in Southern California. The insect was most abundant during November and December and practically all of the late peppers in the infested fields were destroyed. Injury to the pods resulted in decay which usually started in the seed cluster and in small peppers the growth was checked and the pods distorted.

On November 23, 1923, the writer's attention was called to the condition of a 5-acre field of Chinese Giant bell peppers about 2 miles north of La Habra, in the southern part of Los Angeles County, Calif. The grower stated that an insect was damaging the peppers to such an extent that he would not even recover the cost of the seed from the planting. The pods set profusely, but became misshapen, turned red prematurely, failed to mature, and many dropped from the plant. On examination they proved to be infested with small larvae. Some pods were collected, from which a few days later small beetles emerged. These were identified by Dr. F. H. Chittenden as *Anthonomus eugenii* Cano, the pepper weevil.[1] This is the first record of the occurrence of this insect in California. It was previously recorded from Texas,

[1]This species is treated under the name of *Anthonomus aeneotinctus* Champion in Bulletins 54 and 63, Bureau of Entomology, U. S. Department of Agriculture.

where the crop of bell and tabasco peppers was seriously injured in 1903, 1904, and 1905.[2]

On November 30, 1923, other fields about 4 miles distant were examined. They totaled 30 acres, but included three separate plantings, two in the bottom of small valleys and the third on a hilltop 150 feet higher and at a distance of one-half mile. One field was in peppers for the first time, while the others had been planted to peppers for several years. Aside from these three fields, no other peppers had been grown within 5 miles during the preceding five years. All three fields had produced large crops; an average of nearly 400 crates (40 pounds each) to the acre in the best field had already been picked, and there were indications that the entire acreage would average this amount. Careful examination showed a high percentage of infested peppers. Those practically matured were not visibly damaged to an extent that would render them unmarketable, but nearly all immature peppers were so badly infested that it was doubtful if they would develop. This later proved to be the case, for after the remaining mature peppers were picked, only a few more crates were taken from the fields. Although the bulk of the crop had been picked the loss was heavy, because it is the late peppers which bring the high price. The loss caused by the insect in the La Habra district was estimated at from $12,000 to $15,000. The growers in this locality stated that they had observed similar damage in previous years, but that it was so insignificant that no investigations of its cause were made.

The horticultural commissioner of Orange County observed infestation in peppers about December 1, 1923, in Bell Canyon, Orange County about 30 miles southeast from the La Habra infestation. The owner reported that he had grown a few peppers for home consumption for several years but that the nearest fields of peppers grown on a commercial scale were at least 30 miles distant. The peppers were badly infested and on advice of the commissioner they were pulled and burned.

Several pepper fields in the San Fernando Valley were inspected on December 11, 1923. These were about 50 miles northwest from the La Habra fields and on a gentle slope some distance from the nearest hills, while the La Habra fields were among low hills. In one field, from which the commercial crop had been removed, 10 per cent of the remaining peppers were infested, but in fields one-half mile to a mile away no weevils were found.

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[2]Walker, C. M. Bulletin 54, Bureau of Entomology, U. S. Department of Agriculture.

According to Walker,[2] oviposition occurs in small buds, blossoms and young fruit. Whether or not the females select blossoms or pods of a certain stage could not be determined by the writer, but more immature than mature pods were infested and damaged. Infestation occurred in even the smallest peppers, including those no bigger than the end of one's little finger. When the larger pods become infested, no apparent damage is done, the peppers mature and are still marketable, but an infestation in small pods checks growth and causes them to be deformed and almost invariably unfit for market. The larvae may feed and develop in the pepper wall, but are more often found in the seed cluster. The feeding tunnel is surrounded with brownish frass, and pupation takes place within a cell formed from this material. The brownish masses of frass surrounding the larval tunnels and pupal cells present an unsightly appearance when the pepper is opened. Decay usually begins around these masses, so that the middle of the pepper may have a number of decayed spots, or may be a mass of decay.

Although feeding is light, it is quite apparent that the presence of the insect in the smaller pods causes malformation of the peppers, checks growth, and causes them to turn red prematurely.

On December 4, 1923, an examination of peppers on 25 plants in various parts of the field at La Habra showed that of the immature peppers 73 per cent were infested, while of the mature peppers only 20 per cent were damaged. By December 24, however, an examination showed 100 per cent infestation. The number of insects in these pods is shown in the following table.

TABLE I.—NUMBER PER POD OF DIFFERENT STAGES OF THE PEPPER WEEVIL FOUND IN BELL PEPPERS AT LA HABRA, CALIF., DECEMBER 24, 1923

Larvae		Pupae		Adults		Total Number, all stages
Max.	13	Max.	10	Max.	3	23
Min.	1	Min.	0	Min.	0	1
Ave.	3.6	Ave.	1.6	Ave.	.45	5.75

On January 7, 1924, an examination of old peppers still on the plants at La Habra showed, for 10 pods taken at random, a total of 11 adults, 2 pupae, and 1 larva, while by January 12, living adults were found in many pods, but only a few pupae and no larvae. By this time plant growth had entirely stopped, and all peppers were red and small.

ADIRUS TRIMACULATUS SAY—A ROSE PEST

By A. B. Champlain, *Pennsylanvia Bureau of Plant Industry*

Abstract

Adirus trimaculatus (Say), a sawfly of the family Cephidae, known as a borer in blackberry canes in the larval stage, is definitely identified as the borer doing similar damage in rose stems.

It is suggested that infested portions of plants be removed and destroyed. Extensive control measures have not been attempted, and there is room for considerable investigational work both of a biological and economic nature.

Larvae of *Adirus trimaculatus* (Say) are known to be borers in blackberry canes and in a number of instances have been suspected of being a rose pest. At times during the past five years, correspondents of the Pennsylvania Bureau of Plant Industry have submitted samples of rose twigs and shoots that were injured by borers in the form of whitish larvae that tunnel the stems and kill the terminals, with the request for identification and remedies.

In addition to our own provisional identification of this insect as *Adirus trimaculatus*, some of the material was sent to Mr. S. A. Rohwer, Specialist in Hymenoptera, at the United States National Museum, who replied as follows: "We have received similar larvae from rose on a number of occasions, but so far the adult has never been reared and the identification is based entirely on the larva, but is supplemented by the fact that we do not know any large Cephid other than Adirus which could be associated with it."

Mr. William Middleton[1] writes concerning the larva: "This species is recorded boring in blackberry, while the specimens described was received through Dr. F. H. Chittenden's office as coming from rose."

Dr. E. P. Felt[2] mentions that larva as follows: "The reception of a horn tail larva, possibly that of *Adirus trimaculatus* (Say), breeding in rose shoots at Woodhaven, was unusual and may mean the introduction of a new rose pest."

The late John B. Smith, in "The Insects of New Jersey," records this species and comments: "The larva bores in the stems of blackberry canes entering at the bottom and eating out the center to the top." This is just the reverse of what actually happens, the larvae work from the tips down through the center of the canes.

The adults of *Adirus* fly during the latter part of May and through June and July in Pennsylvania and on July 12, 1924 the author was for-

[1]Notes on the larva of some Cephids, Proc. Ent. Soc., Wash. Vol. XIX, P. 177, 1917.

N. Y. Report 32, Page 60, 1918.

tunate in finding females ovipositing on the tender new rose shoots. These females were first observed flying around the rose bushes in the yard, alighting from time to time on the terminals of the new shoots that had made their growth during the season. Always head downward, they moved in that direction, using the tip of the abdomen and sometimes the ovipositor as a tactile organ, inserting the latter at short intervals into the soft tender growth. But a second was required to insert an egg which was placed in the pith at right angles to the outer bark.

Considerable damage is done by the females in puncturing the buds and terminals, several dozen punctures were observed along a distance of a few inches, although it is very likely that but few contained eggs.

After hatching from the egg, the larva that gets the first start is apparently the only one that makes good in a single terminal, no instance of more than one in any completed tunnel was observed. Beginning with the terminal, which wilts and dies, the larva feeds on the pith, packing the excrement behind it as it travels through the stem, sometimes for considerable distances, varying with the length of the shoots and the time when the egg was deposited in relation to the season.

At certain intervals the larva makes a girdle on the inside of the stem above where it is feeding and working and frequently the stem breaks at this point. When full grown the larva makes an opening partially through the stem to the outside, and spins a cocoon and overwinters in the space that it last occupied when feeding. Pupation probably takes place in the spring and our first records of adults are on May 21.

Records in the collection of the Bureau of Plant Industry show that adult specimens were taken:

Dauphin County, Pa.,—May 21, J. N. Knull;
" " " —June 1, A. B. Champlain;
" " " —June 30, H. B. Kirk;
" " " —July 4, J. G. Sanders;
" " " —July 12, A. B. Champlain.

Records in the files show that larvae were found in stems during June and July. At Harrisburg, Pa., June 15th, Mr. P. T. Barnes found larvae about one-half grown boring in the new growth of American Pillar roses. Letters from correspondents refer to finding larvae in stems during July. On July 12 at Harrisburg where the observations on the oviposition of of this species were made, several stems contained small larvae.

Cutting off the infested tips as soon as injury or wilting is noticed and before the larvae work very far down the stem, would be about the surest

and simplest remedy. After the larvae work down the stems it will be more difficult to locate them, the stems may look green and healthy but the borings or frass in the center of the stem will show that the larvae have not been reached. Cut below this area and burn cuttings.

THE PREPARATION FROM TOBACCO OF A SOLUTION FOR SPRAYING[1]

By O. M. Shedd and A. J. Olney, *Kentucky Agricultural Experiment Station*

Abstract

The only grade of Kentucky tobacco, other than stems and stalks, which can be used profitably at present prices for making a spray solution is common trash. This is chiefly composed of diseased and damaged leaf. It has a widely variable and generally low nicotine content but usually contains more than stems and stalks of the same variety. The range for 79 samples of white Burley and dark tobacco was from 0.26 to 4.50 per cent nicotine in the air-dry trash.

Angular leaf-spot and wildfire lower the nicotine content but not the nitrogen content of the leaf. The nicotine content of the leaf which cured with a green color was not affected to the same extent as that of diseased leaf.

Infusions made from 26 samples of trash, using such quantities of cold water as would give .05 to .07 per cent of nicotine in the solution, as computed from analyses of the samples, were about equally effective in exterminating aphis. Lower concentrations were not as satisfactory.

Black Leaf 40 solution diluted to contain 3.5 per cent of nicotine did not injure tomato plants. Higher concentrations caused injury which was partly preventable by soap.

It is important that the approximate nicotine content of trash used to make a spray solution should be known. If it is not, then a low percentage of nicotine must be assumed. This probably should be about 1 per cent for white Burley and 1.7 per cent for dark trash grown in Kentucky.

The object of this paper is to emphasize the importance of having some knowledge concerning the nicotine content of tobacco which is to be used for the home preparation of a spray solution. This should be given first consideration and if it is disregarded, unsatisfactory results will frequently be obtained and this may create prejudice against all such preparations, including commercial nicotine solutions which undoubtedly have demonstrated their merit.

Nicotine is the characteristic alkaloid of tobacco and is a very powerful poison, particularly for certain insects. A solution of it has the peculiar advantage that a moderately excessive amount does not injure

[1]Approved by the Director of the Kentucky Agricultural Experiment Station, and read at the symposium on insecticides and fungicides of the American Chemical Society at their meeting in Washington, D. C., April 21–25, 1924.

tender plants. It is used more than any other insecticide to destroy aphis or plant lice. Various concentrated extracts of tobacco are now on the market and with proper dilution they can be used with unvarying success provided their guaranteed content of nicotine is present. Furthermore, they can usually be added to certain other insecticides without detriment to either.

The question frequently arises whether diseased, damaged or waste tobacco that cannot be profitably sold may be used for the preparation of a spray solution. The answer would be that it can, provided its approximate nicotine content is known. The nicotine content of tobacco varies greatly depending on many factors such as variety, fertility and character of soil, climate, season, curing, blight or disease and other possible causes.

Tobacco stalks contain less nicotine than the stems and the latter less than the leaf. The leaves nearest to the ground contain less nicotine than the upper ones. With respect to the Burley plant, the lower leaves are lighter in color and go into the smoker grades while the middle and most of the upper ones are included in the red filler grades and wrappers. It so happens that at present prices, the only kinds of tobacco which probably can be profitably used for sprays comprise stalks, stems and common trash. The last consists chiefly of sweepings, refuse, and diseased and damaged leaf and usually contains relatively the smallest nicotine content of any grade. It usually has more nicotine, however than stalks or stems and is to be preferred when it can be obtained at a low cost. It seems that the factors which vitiate the quality of the leaf also materially reduce its nicotine content, with the possible exception when matured leaf cures with a green color in the barn. It is thought by some growers that this is caused by exposure to chilly winds in the curing. This color materially reduces the value but will often disappear after the tobacco is bulked for a short time and put thru the dryer. The nicotine content of tobacco with this green color does not appear to be affected to the same extent as that of tobacco which is house burned or diseased. For illustration, two samples of this green tobacco were found to contain 1.96 and 2.38 per cent of nicotine in the air-dried leaf, whereas diseased tobacco was found to contain much less, as will be shown later.

The Burley crop of 1920 was probably one of the most inferior ever produced in central Kentucky, due to the prevalance of two diseases now commonly known as wildfire and angular leaf-spot. These diseases were, also, present during the same year in the dark tobacco region of

this state but to a more limited extent. The senior author had occasion at that time to collect a large number of samples of diseased Burley tobacco. This sold on the market at from fifty cents to two dollars per hundred pounds and these prices did not cover the stripping and warehouse charges. The question was often raised then what disposition other than as a fertilizer could be made of this class of tobacco if left on the farm and if any part could be used for making a spray. To arrive at more definite knowledge concerning the latter point the senior author made the chemical investigations described herein and the results obtained suggested the cooperative spray experiments which were later undertaken to corroborate the chemical findings.

Twenty-six samples were selected for the work, eighteen of air-cured Burley and eight of dark tobacco. Six of the latter were fire-cured and the remainder were air-cured. The midrib or stem had been previously removed from three of the Burley and from all of the samples of dark tobacco, in connection with some other work. The dark tobacco was freer from disease and in most instances had a market value that would probably not permit its use in making sprays. Diseased samples of this tobacco could not be obtained at the time. All the Burley samples, however, were more or less infected with wildfire and angular leaf-spot. Nicotine determinations were made on the air-dried samples with the following results:

TABLE 1—PERCENTAGE OF NICOTINE IN AIR-DRIED COMMON TOBACCO TRASH USED IN SPRAYING EXPERIMENTS.

	Maximum	Minimum	Average
Burley, 18 samples	2.93	0.26	1.07
Dark (fire-cured) 6 samples	4.30	0.98	2.57
Dark (air-cured) 2 samples	4.48	2.16	3.32

The sample of Burley containing only 0.26 per cent of nicotine in Table 1 may be exceptional. The next higher percentage of nicotine found was 0.68 per cent, making the range in 17 samples from 0.68 to 2.93 per cent, and the average 1.12 per cent. The nicotine content of a majority of the samples was close to this average.

To a convenient weight of each of the above powdered samples, the required volume of cold tap water was added so that the resulting solution would contain .07 per cent of nicotine, assuming that a complete extraction of it would be obtained. The samples were allowed to remain in the cold water for 24 hours and the solution, after decantation, was used as a spray. It is doubtful if all the nicotine was extracted but if seventy per cent or more was obtained, which is probable, the solution

would have contained about .05 per cent. The strength generally recommended is from .05 to .07 per cent.

The solutions were applied to aphis on tomatoes in the greenhouse and on plum trees in the open. The results were about the same with all samples. All small or medium sized aphis were killed in 2 hours and practically all the remaining or large ones after 24 hours. The number under observation in the individual experiments generally was two to five hundred and it was noticeable that the few which survived after 24 hours' observation were all full-grown. The medium sized and small ones were always killed. The highest percentage surviving was 3 per cent, in only one case, but generally only about 1 per cent, by actual count, survived after 24 hours.

The foregoing results were obtained with freshly prepared solution. One of these solutions which, when fresh, had killed all the aphis, was tried again after standing for nearly a week; it was found to exterminate only 82 per cent of the aphis. In the meantime, however, the decoction had commenced to ferment and had developed a disagreeable odor. This indicates that the fresh solution should be used or some preservative added.

One tobacco was tried on aphis by taking the fresh solution which was found to exterminate all and diluting it with 1, 2, 4 and 8 parts of water. The degrees of extermination after 24 hours' observation were 76, 79, 30 and 11 per cent, respectively. The aphis in the experiment which gave 79 per cent extermination were smaller than the others, which accounts for a larger number killed in this case. In all cases, the surviving aphis were of the larger size. It appears from these particular experiments that the solution should contain at least .05 per cent of nicotine for effective results; in fact, it might be preferable for it to have about .10 per cent to get rid of all mature aphis in a few hours where it was to be applied in the open with a probability of rain washing it off before all were killed.

The results clearly demonstrate that if recommendations are to be made for preparing sprays from tobacco the nicotine content of which is not known, a very low percentage would have to be taken as a standard for any particular variety, otherwise unsatisfactory results would frequently be obtained. On the other hand, by accepting such a low standard, some solutions would necessarily carry very much larger amounts of the alkaloid than is desired, due to its higher percentage in the samples from which they were prepared.

In order to determine if a reasonable excess of nicotine would affect tender plants, different concentrations of Black Leaf 40 were used on tomato plants in the greenhouse. It was found that the plants were not injured after an interval of 2 days by a solution containing approximately 3.5 per cent nicotine or about 50 times the concentration generally recommended. Solutions stronger than 3.5 per cent apparently injured the plants and the injury was more noticeable as the concentration was increased.

Inasmuch as soap is commonly used in nicotine sprays, another set of experiments was made in which soap was added to the solution. This was found to partly prevent injury.

It will be of interest for comparison to give the amounts of nicotine which were found in a much larger number of samples of common trash, especially of Burley, than were used in the spraying experiments. The samples used in that work, however, are included in the table. They were taken from the 1920 and 1921 crops but the latter crop of Burley was freer from disease, and a large number of the samples selected from it included mixed common filler and smoker grades which had a market value that would not permit their use for sprays. They would ordinarily be considered as common trash, however. As they had been used in connection with other work, the stem had been removed from all except 15 samples of the Burley.

TABLE 2—PERCENTAGE OF NICOTINE IN AIR-DRIED COMMON TRASH OF 1920 AND 1921 CROPS.

	Maximum	Minimum	Average
Burley, 63 samples	4.00	0.26	1.75
Dark (fire-cured) 10 samples	4.50	0.98	3.06
Dark (air-cured) 6 samples	4.48	2.16	3.22

The Burley sample containing 0.26 per cent nicotine may be exceptional. If this is omitted, the range for 62 samples is from 0.67 to 4.00 per cent, and the average 1.77 per cent.

In order to illustrate the effect of disease on the nicotine and total nitrogen content of tobacco, two lots of Burley were selected. One lot consisting of 5 hands was appreciably infected and the other of 10 hands was very badly infected with wildfire. Representative samples of leaf with the stem present were taken from each hand of the two lots and individual nicotine and total nitrogen determinations were made. The remainder of each lot then had the stem removed and composite samples of each were used for analysis. The results follow:

TABLE 3—PERCENTAGE OF NICOTINE AND TOTAL NITROGEN IN AIR-DRIED COMMON TRASH, INFECTED WITH WILDFIRE.

	Appreciably infected			Badly infected		
	Max.	Min.	Ave.	Max.	Min.	Ave.
Leaf including stems. Nicotine	2.93	0.68	1.32	1.27	0.69	0.94
Total nitrogen	4.35	2.23	2.96	4.20	2.56	3.46
Composite of samples above with stem removed. Nicotine			1.84			1.21
Total nitrogen			3.37			3.98

It will be observed in Table 3 that the badly infected tobacco has less nicotine but more nitrogen than the other and that the removal of the stem increases the average amounts of these constituents in both kinds of tobacco.

It was impossible to obtain for the spray work a sufficient number of samples of diseased dark tobacco, therefore those that were used represent a better quality than would be employed for this purpose.

If general recommendations were to be made based on the results reported here together with a large number of nicotine determinations on other grades of both kinds of Kentucky tobacco, it would probably be safe to assume that such Burley as might be used for spray solutions would contain about 1 per cent, and dark tobacco about 1.70 per cent of nicotine.

Any sample which is to be used for the preparation of a spray solution should be rendered as fine as possible so as to permit a more thoro extraction. In no case, however, will a complete solution of the nicotine probably be obtained under practical working conditions. Of course the judgment of the user would prevail as to whether any lot of tobacco could more profitably be used in a spray solution but in arriving at a decision it must be remembered that a considerable proportion of the fertilizing ingredients still remains in the residue after the extraction of the nicotine and this may be used as a fertilizer.

SUMMARY

The only grade of Kentucky tobacco, other than stems and stalks, which can be used profitably at present prices for making a spray solution is common trash. This is chiefly composed of diseased and damaged leaf. It has a widely variable and generally low nicotine content but usually contains more than stems and stalks of the same variety. The range for 79 samples of white Burley and dark tobacco analyzed is from 0.26 to 4.50 per cent.

Angular leaf-spot and wildfire lower the nicotine content but not the nitrogen content of the leaf. The nicotine content of the leaf which

cured with a green color is not affected to the same extent as that of diseased leaf.

Infusions made from 26 samples of trash, using such quantities of cold water as would give .05 to .07 per cent of nicotine in the solution, as computed from analyses of the samples, were about equally effective in exterminating aphis. Lower concentrations were not as satisfactory.

Black Leaf 40 solution diluted to contain 3.5 per cent of nicotine did not injure tomato plants. Higher concentrations caused injury which was partly preventable by soap.

It is important that the approximate nicotine content of trash used to make a spray solution should be known. If it is not, then a low percentage of nicotine must be assumed. This probably should be about 1 per cent for Burley and 1.7 per cent for dark trash grown in Kentucky.

LEAD ARSENATE, LIME-SULFUR, AND TOBACCO DUST AS A TRIPLE SPRAY MIXTURE

By Leon R. Streeter, *Geneva, N. Y.*

The possibility of using tobacco dust as a source of nicotine in lime-sulfur-lead-arsenate sprays is being investigated at the New York State Agricultural Experiment Station.

It seemed advisable to determine the amount of nicotine dissolved from fine ground tobacco dust by lime-sulfur.

The tobacco dust contained 1.2 % of nicotine. In making the spray mixture in quantities for field work 200 lbs. of tobacco was added to 100 gals. of concentrated lime-sulfur. The mass was stirred thoroly to insure intimate mixture. The following day the mixture was again stirred and a sample taken for nicotine analysis. In experiment Nos. 1 and 2 the tobacco dust was added to hot lime-sulfur. In experiment No. 3 the lime-sulfur was allowed to cool before adding the tobacco dust. The results of these experiments are given in Table No. 1.

Table 1.—Showing the Solubility of Nicotine in Lime-Sulfur

Experiment number	Tobacco dust	Lime-sulfur	Time of soaking	Nicotine soluble
	lbs.	gals.	hrs.	%
1	200	100	18	82
2	200	100	24	94
3	200	100	24	86

Some additional experiments were performed in the laboratory, using convenient volumes, to compare the solvent action of water with that of lime-sulfur, also to determine the amount of nicotine recovered in the filtrate when separated from the sludge. In the following experiments a tobacco dust containing 3.6 % nicotine was used. The results of these experiments are given in Table No. 2.

TABLE 2.—SHOWING THE RECOVERY OF NICOTINE IN WATER AND LIME-SULFUR FILTRATES

Experiment number	Solvent	Agitation	Time of soaking	Filtrate recovered	Nicotine recovered
		Hourly hrs.	hrs.	%	%
4	Cold H_2O	6	24	76.9	71.9
5	Hot "	6	24	76.9	70.6
6	Cold "	6	48	73.6	87.1
7	Cold—S	6	24	75.5	77.6

Ramsay and Griffiths[1] report a recovery of 63 % to 72.7 % nicotine soluble in water. The fact that these writers used a dust containing less than 1 % of nicotine may account for the somewhat lower nicotine yield reported by them. The same experimenters also state that the addition of lime does not appreciably increase the quantity of nicotine soluble in water, but state that a clearer solution can be obtained when lime is added, due to precipitation of much of the organic matter by the calcium. Experiments carried on in this laboratory agree with this statement, as shown by the results in Table No. 3.

TABLE 3—SHOWING THE EFFECT OF ADDING CALCIUM HYDRATE

Experiment number	Solvent	Soluble nicotine
		%
8	Cold H_2O	92.1
9	Cold H_2O 2 lbs. $Ca(OH)_2$	92.09

Study of these data will show that there is but little difference in the solvent action of water and lime-sulfur and that heating the solvent does not increase the quantity of nicotine found in solution. It is likewise evident that the addition of an alkaline substance such as hydrated lime does not increase the solvent power of water.

[1]Ramsay, A. A., and Griffiths, E. L. The Preparation of Home-Made Tobacco Wash. Agr. Gazette of New South Wales. Vol. 35, Part 4. 1924.

When tobacco dust is added to lime-sulfur some hydrogen-sulfide may be liberated. This difficulty can be partially overcome by the addition of a few pounds of hydrated lime per 100 gallons of spray mixture. No test for H_2S was obtained when the filtrate from experiment No. 9 was added to lime-sulfur solution.

From a theoretical standpoint nicotine should be readily volatilized from alkaline lime-sulfur solution. A few preliminary experiments on the volatility of nicotine from this mixed spray have been made. These experiments indicate that the rate of volatility is about the same as that from other preparations of the same nicotine content.

The chemical compatability of this triple spray is discussed in Bulletin No. 521 of this station.[2]

THE EFFECTS OF OIL SPRAY ON APPLE APHIDS

By K. C. Sullivan and O. C. McBride

In certain sections of the Mississippi Valley the lubricating oil emulsions have been used as a dormant spray for the control of San Jose Scale with a certain degree of success. The question has been raised as to the effect of these emulsions on apple aphids. The common practice is to apply a separate spray of nicotine sulphate just as soon as the aphids hatch. This extra spray costs considerable in both time and material. Some growers however, have added the nicotine sulphate to the first summer spray of lime sulphur and arsenate of lead. This has been fairly satisfactory but is just a little late for the most effective results.

The lubricating oil emulsions have been used extensively at the Missouri Agricultural Experiment Station during the past two years in order to determine their value as a dormant spray and also as a summer spray on apple trees. During the course of this work extensive observations were made as to the efficiency of these sprays in controlling apple aphids.

The aphis which has caused the most trouble in Missouri on apples during the past two years is the common grain aphis (*Siphocoryne avenae* Fab.) This aphis migrates to the apple in the fall from the grain and deposits eggs on the small twigs and buds. At the time the buds begin to push out in the spring the eggs hatch. From three to four generations are reared on the apple before they migrate back to the grain. They are often present in large numbers and cause considerable damage to the young tender growth.

[2]Thatcher, R. W., and Streeter, Leon R. Chemical Studies of the Combined Lead Arsenate and Lime-Sulfur Spray. N. Y. S. Agr. Exp. Sta. Bul. No. 521. 1924.

The following varieties of apples were sprayed and counts made to determine aphid control: Rome Beauty, Delicious, Jonathan, Winesap, Ben Davis, Grimes Golden, Black Ben Davis, Liveland Raspberry, Stayman Winesap, Paragon, Early Harvest, McIntosh, Ben Hur, King David, Ingram, Ginnie and Bauer Sweet.

EXPERIMENTS 1923

Treatment	Date sprayed	Date Counted	No. buds	Aphids Alive	Ave. per bud
1.—Lime Sulfur 1–7	4/9/23	4/12/23	110	319	2.8
2.—Soap Oil Emulsion 2%	4/9/23	4/13/23	64	271	4.23
3.—Soap Oil Emulsion 1% with $CuSo_4$	4/10/23	4/16/23	102	319	3.12
4.—Soap Oil Emulsion 2% with $CuSo_4$	4/10/23	4/16/23	113	93	.823
5.—Kayso Oil Emulsion	4/10/23	4/13/23	38	32	.842
6.—Lime Sulfur 1–7	4/11/23	4/17/23	33	12	.363
7.—Soap Oil Emulsion 2%	4/11/23	4/12/23	57	285	4.52
8.—Check		4/14/23	33	164	4.97
9.—Check		4/17/23	16	95	5.93
10.—Check		4/18/23	82	575	7.01

EXPERIMENTS 1924

Treatment	Date Sprayed	Date Counted	No. Buds	Aphids Alive	Ave. per bud
1.—10% Kayso Oil Emulsion Dormant	2/22/24	4/25/24	150	194	1.29
2.—Lime Sulfur 1–7	4/11/24	4/12/24	152	43	.282
3.—10% Kayso Oil Emulsion Delayed Dormant	4/12/24	4/25/24	124	43	.346
4.—10% Kayso Oil Emulsion Delayed Dormant	4/12/24	4/25/24	150	51	.34
5.—2% Kayso Oil Emulsion	4/14/24	4/25/24	150	546	3.64
6.—2% Kayso Oil Emulsion	4/14/24	4/15/24	51	8	.15
7.—4% Kayso Oil Emulsion	4/14/24	4/25/24	100	346	3.46
8.—Lime Sulfur 1–7	4/14/24	4/25/24	100	901	9.01
9.—1% Kayso in Lime Sulfur	4/21/24	4/25/24	100	48	.48
10.—Kayso Oil Emulsion 2% with 3–4–50 Bord.	4/21/24	4/25/24	450	879	1.95
11.—Check		4/15/24	292	198	.678
12.—Check		4/25/24	450	1659	3.46

The preceeding tables show the kind of sprays used, date spray was applied, date counts were made, number of buds counted, number of aphids alive and the average number of live aphids on each bud.

It will be noted that in no case did any of the spray materials used give effective control as compared to the checks. With one exception,

the 10 % Kayso Oil Emulsion applied as a dormant spray, all sprays were applied after the eggs had hatched and as the data shows some of the emulsions as well as the lime sulfur gave partial control but not enough to warrant recommending them. For the regular dormant spray for San Jose Scale a 2% emulsion is usually recommended. In this work it will be noted that a 10% oil emulsion was tried and still not enough control was obtained to recommend its use. From the results obtained it seems evident that lime sulfur or lubricating oil emulsions cannot be recommended for complete control of apple aphids.

ANOTHER LEAD BORING BEETLE

By W. J. Chamberlin, *Forest Entomologist, Oregon State College*

A rather remarkable specimen of insect injury has been submitted to the writer by the Portland Railway Light and Power Company. Owing

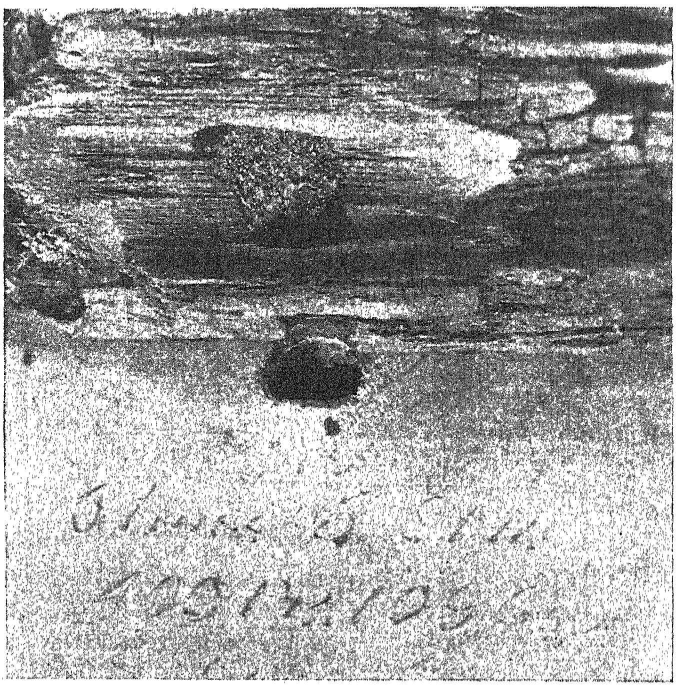

Fig. 19.—Work of *Callidium?* in cedar and lead. A portion of the tunnel in the wood and the exit hole thru almost 3/16 of an inch of lead can be seen. The granulated material stored in the mine is lead borings.

to interference of current a portion of underground cable was removed and found to have been punctured by insects. The cable covering was

of creosoted cedar and lead plate, the latter 3.5 mm. in thickness.

The larvae, evidently a *Callidium*, had matured in the cedar and worked out thru the lead, storing the lead borings in the mine behind it just as if they were wood borings. The two emergence holes in the lead plate measure 4 by 10 mm. and 4 by 5 mm. This latter looks as tho the insect may have failed to get thru. The hole is 9 by 6 mm. on the inside and 4 by 5 mm. on the outside. The lead borings resemble pellets more than shavings, they range in size from one to four-tenths of a millimeter in diameter, many distinctly show the marks of the mandibles.

Another case of a beetle, evidently a Buprestid, penetrating lead was brought to my attention, some two years ago, at Portland, Oregon. In this case the insect emerging from a pole encountered a lead covered cable running down the pole to pass under a railroad. The lead sheath was one-quarter inch thick and the beetle gnawed a groove in the side of it one-quarter inch wide and about three-sixteenths inch deep, this enabled it to escape—at the same time the hole did not penetrate entirely thru the cable.

TREE CRICKET INJURY TO PRUNES

By M. A. Yothers, *Yakima, Washington*

The Tree Crickets, *Œcanthus spp.*, are generally known as beneficial insects since they feed very largely upon plant lice. In a minor way they are sometimes recognized as of economic importance on account of the injury their oviposition punctures cause to raspberry canes and fruit tree twigs. During the past several years, however, and especially the past two seasons these crickets have become one of the most important insect pests in the extensive prune orchards of southern Idaho, causing an annual loss of hundreds of thousands of dollars.

When the crickets (one species of which is *Œcanthus niveus* De Geer) become about two-thirds grown or reach their fourth or fifth instars, they begin feeding upon the half-grown prunes, gnawing holes about over the surface and often deep down into the fruit (Plate 13). This injury starts about the first of August and continues until the prunes are harvested or about the last half of September. Before the prunes are harvested the crickets have reached maturity and continue their feeding with even greater avidity than before.

It often happens that the per cent of tree cricket-injured fruit is so great that it does not pay to harvest, sort and pack the crop. When the per cent of injury is above 50% it is usually considered too expensive to sort and handle it. Not only is the injured fruit rendered unsightly and below the requirements for packing regulations, but it soon starts to

decay after being packed, especially in cold storage, and soon breaks down, becoming slimy and extremely disagreeable. This slime of the mouldy prunes spreads to adjoining prunes and then throughout the whole package, rendering the entire box unmarketable and unfit for use. This condition usually occurs in storage at the point to which the fruit has been shipped after the grower has been to the expense of paying freight or express charges.

Some idea of the number of these tree crickets can be gained when it is pointed out that Mr. Claude Wakeland, Entomologist of the University of Idaho, has counted as high as 1386 individuals killed under a single tree.

APPLICATION OF THE RONTGEN TUBE TO DETECTION OF BORING INSECTS

By N. Yaghi, *Special Entomologist in the Government Agricultural Experiment Station, Nishigahara, Tokyo, Japan*

The röntgen tube has ever been used in experiments on the effect of the rays on development of insects and sterilization of gonads. I used

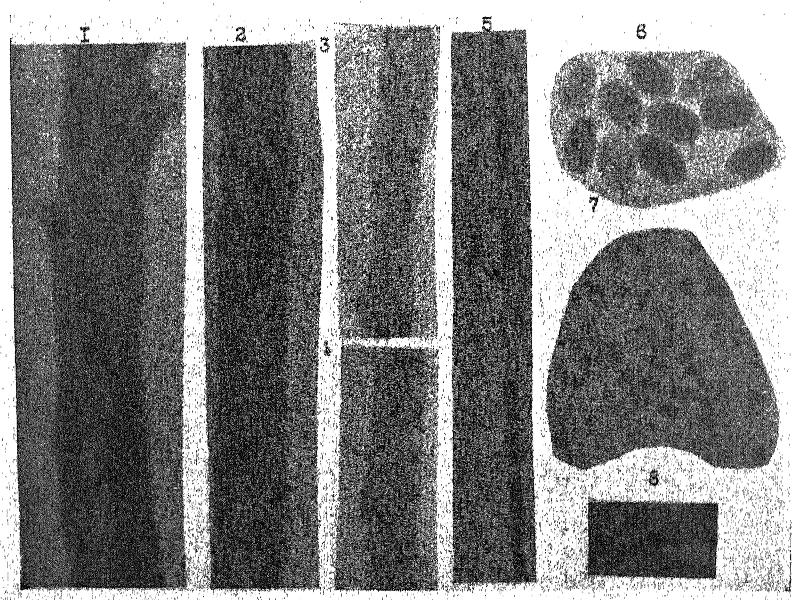

Fig. 20.—1, *Apriona rugicollis* Chev. in apple tree; 2, *Melanauster chinensis* Först. in apple tree; 3, *Chreonoma fortunei* Thom. in pear stem; 4, *Sciapteron regale* Butl. in grape tree; 5, *Chilo simplex* Butl. in rice straw; 6, Bean grains bored by *Pyralis farinalis* L.; 7, Larvae and pupae of *Calandra oryzae* L. in rice grains; 8, *Tinea pellionella* L. in wool matter.

Tree Cricket Injury to Prunes (Original)

the tube as in medical diagnostics to detect boring insects in their food substances and got successful results with the following species of larvae: *Apriona rugicollis* Chev. in mulberry tree, *Batocera lineolata* Chev. in chestnut tree, *Melanauster chinensis* Först. in apple tree, *Sciapteron regale* Butl. in grape tree, *Pyralis farinalis* L. in bean grain, *Tinea pellionella* L. in wool, *Calandra oryzae* L. in rice grain, *Chilo simplex* Butl. in rice straw and *Ptinus fur* L. in blankets. Under laboratory conditions tests on woody plants made with a coolidge tube permitting a medium high energy input in voltage 84000, amperage 4.3 m. a. and hardness 6.3° , or a less intense ray on rice straw and wool. I suggest the röntgen tube may be a very useful apparatus for studying the life of boring or parasitic insects.

Ethyl Acetate—Carbon Tetrachloride Mixture. On April 7, 1922, the General Managers' Association of Chicago (representing the leading railway systems in the United States) prohibited, because of the fire hazard involved, the use of carbon disulphid and a mixture of carbon disulphid and carbon tetrachloride for fumigating railway cars except at points at New Orleans and Baltimore. As a result of a resolution adopted at the same time and presented to the Secretary of Agriculture, an agreement was drawn July 17, 1922, by the Bureaus of Chemistry and Entomology which has resulted in a study of the toxicity of over one hundred organic compounds and various combinations of these upon *Sitophilus oryza* and *Tribolium confusum.* A technical bulletin, "Fumigation Against Grain Weevils with Various Volatile Organic Compounds," has been prepared by the Bureaus giving the results of the work from July, 1922, to the spring of 1924. This work and that of the summer of 1924 indicates that a mixture of four volumes of ethyl acetate and six volumes of carbon tetrachloride gives an effective non-inflammable and non-explosive fumigant against adult weevils in wheat in grain cars. These two fumigants must be tested for freedom from odoriferous constituents of low volatility or undesirable odors will be retained by the wheat, flour, and the finished loaf of bread. The ethyl acetate should be at least 99 per cent pure. Since the vapor pressure of ethyl acetate and carbon tetrachloride is almost the same, a mixture of the two vaporizes practically as if it were a single compound.

At present forty pounds of the mixture is recommended for each thousand cubic feet of space. The mixture can be had at about ten cents per pound. Since the average capacity of a box car is 2,750 cubic feet and contains on an average about 1,300 bushels of wheat, the cost of fumigating amounts to about 85 cents per 100 bushels. At present the average discount of weevily wheat is about 2 cents per bushel. This charge is prorated as follows: ½ cent for fumigation with carbon disulphid, 1/8 cent for blowing and screening, 1-3/8 cents for dockage. Since the ethyl acetate-carbon tetrachloride mixture costs about 1 cent per bushel, the new fumigant will add to the cost of fumigation, but the extra cost will be offset by the freedom from fire hazard.

Further work must be done outside of grain car fumigation to determine the place this fumigant will take in practical control work.

E. A. BACK and R. T. COTTON, *Stored Product Insect Investigations, Bureau of Entomology*

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

(Organized 1899, Incorporated December 29, 1913)

CONSTITUTION

ARTICLE I

Name and Objects

SECTION 1. This association shall be known as the American Association of Economic Entomologists.

SECTION 2. Its object shall be: (1) To discuss new discoveries, to exchange experiences, and to carefully consider the best methods of work in economic entomology; (2) to give opportunity to individual workers of announcing proposed investigations so as to bring out suggestions and avoid unnecessary duplication of work; (3) to suggest when possible, certain lines of investigation upon subjects of general interest; (4) to promote the study and advance the science of entomology; (5) to publish the Journal of Economic Entomology.

ARTICLE II

Membership

SECTION 1. All economic entomologists, horticultural or apiary inspectors, employed by the General or State governments or by the State experiment stations, or by any agricultural or horticultural association, and all teachers of economic entomology in educational institutions and other persons engaged in practical work in economic entomology, may become members.

SECTION 2. The classes of membership shall be active, associate, and foreign. Active membership shall be conferred only on persons who have been trained in entomological work and whose practical experience or published papers have evidenced their ability to conduct original investigations in economic entomology.

SECTION 3. Associate membership may be conferred on persons who have done general or practical work in entomology and who have by published papers or otherwise, given evidence of their attainments in such work.

SECTION 4. Foreign membership shall be honorary and shall apply only to members residing outside of the United States and Canada.

SECTION 5. Associate and foreign members shall not be entitled to hold office or to vote.

SECTION 6. Membership, other than foreign membership, may be conferred at any regular meeting by a two-thirds vote of the members present upon recommendation of the committee on membership, after a regular application endorsed by two active members has been filed with the Secretary.

SECTION 7. Foreign members may be proposed in writing by any active member and their names shall be acted upon by the committee on membership and the Association, as in the case of other members.

SECTION 8. Any member who shall pay to the Association the sum of $100 may be made a life member and shall thereafter be exempt from dues and shall be furnished with the Journal of Economic Entomology without further charge.

ARTICLE III

Officers

SECTION 1. The officers shall consist of a president, one vice-president, and an additional vice-president for each branch or section, who shall be elected annually, and a secretary who shall be elected for a term of three years, who shall perform the duties customarily incumbent upon their respective offices and as defined in the by-laws. The above officers shall act as an Executive Committee and shall pass on any urgent matters that cannot be deferred until the annual meeting. The president shall not hold office for two consecutive terms.

ARTICLE IV

Annual Meeting—Quorum

SECTION 1. The annual meeting shall be held at such time and place as may be decided upon by the association at the previous annual meeting and special meetings may be called by order of the Executive Committee. Twenty members shall constitute a quorum for the transaction of business.

ARTICLE V

Amendments

SECTION 1. All proposed alterations or amendments to this constitution shall be referred to a committee of three at any regular meeting, and after a report from such committee, may be adopted by a two-thirds vote of the members present; Provided: That a written notice of the proposed amendment has been sent to every active member of the association at least one month prior to the date of action.

BY-LAWS

ARTICLE I

Of Members

SECTION 1. The classes of members are defined in the constitution as are their rights to vote or hold office. Members of all kinds have equal privileges as to presentation of papers and in scientific discussions at the regular meetings, and may, by permission of the presiding officer, speak on business questions before the association.

SECTION 2. All members in good standing have equal rights to the publications of the association or to any publications controlled or distributed by the association.

ARTICLE II

Of Officers and Their Duties

SECTION 1. It shall be the duty of the president, in addition to the ordinary duties of the presiding officer, to prepare an address, to be delivered at the annual meeting over which he presides. He shall also appoint the necessary committees at the first session of the annual meeting.

SECTION 2. It shall be the duty of the secretary to make the necessary arrangements for the meetings of the association and keep a record of the proceedings for publication, to provide the necessary stationery and attend to the general correspondence. He shall collect moneys due, pay all bills incurred by the association, submit a report at each annual meeting, and perform such other duties as may be delegated to him.

SECTION 3. All officers and standing committees unless otherwise provided for shall be elected by ballot after recommendations have been made by a nominating committee.

SECTION 4. The publication of the Journal of Economic Entomology shall be entrusted to an Editor, an Associate Editor and a Business Manager nominated by an Advisory Committee of six members, which latter shall be elected for terms of three years so arranged that two shall be elected annually. The members of this committee shall have an advisory relation to the above constituted Editorial Board.

ARTICLE III

Dues

SECTION 1. The annual dues of members shall be one dollar and fifty cents, which shall be payable in advance. No dues shall be payable from foreign members. Annual dues shall not include subscription to the Journal of Economic Entomology.

ARTICLE IV

Of Meetings

SECTION 1. Notice of the time and place of meetings shall be sent for publication to all American entomological periodicals. The proceedings shall be published as decided by the association.

SECTION 2. Special meetings shall be called as provided for in the constitution, and notice of such meeting shall be given by the Secretary by mailing to each active member a formal notification of the time and place of the meetings at least two weeks before the date fixed in the notice. The notice shall state the reason for such meeting, and shall specify the business to be transacted, and no other business shall be transacted.

SECTION 3. The order of business at regular meetings shall be, at the first session:

1. Calling the meeting to order by the president.
2. Reports of officers.
3. Reports of committees.
4. Appointments of temporary committees.
5. Written business communications.
6. Verbal business communications.
7. New business.
8. Program of papers and discussions.
9. Adjournment.

At the following sessions:

10. Program of papers and discussions.

    Business can only be introduced at these sessions by vote of the association.

At the last regular session:

11. Program of papers and discussions.
12. Reports of appointed committees.
13. Miscellaneous business.
14. Election of officers.
15. Fixing time and place of next meeting.
16. Adjournment.

ARTICLE V

Amendments to By-Laws

SECTION 1. Changes in these by-laws may be made by a two-thirds vote at any regular meeting: Provided, notice in writing of the proposed amendment be sent to every active member at least two weeks before the date of the meeting, at which time it can come up for consideration.

Scientific Notes

Fumigating Citrus Trees with Calcium Cyanide Dust. Tests are being conducted in California, Florida, South Africa, Australia and Egypt in fumigating citrus trees with calcium cyanide dust. The methods used are similar to the former method of placing a tent over the tree, but instead of using fumigating jars of liquid hydrocyanic acid gas, calcium cyanide dust is blown under the tent, the normal humidity releasing the gas, thereby effecting a true fumigation.

V. I. SAFRO

Calcium Cyanide as a Greenhouse Fumigant. A new principle in cyanide fumigation of greenhouses and nursery stock that is being tested by workers is that of using a lower concentration of gas over a longer period of time (over night) as contrasted with the former method of a higher concentration for a short period of time.

In the sodium cyanide-sulphuric acid method only the latter principle could be followed because of the rapidity, violence and concentration of hydrocyanic acid gas evolved.

Calcium cyanide by its property of gradual evolution of the gas permits of utilizing the former principle whereby the lower concentration of gas affords a wider margin of safety to the plants. V. I. SAFRO

Control of Leaf Cutting Ants. The leaf cutting ants in tropical and subtropical America are receiving considerable attention by the agricultural authorities of a number of countries. Successful tests by authorities of Cuba, Guatemala, Costa Rica, San Salvador, Brazil and Argentina have recently been made with calcium cyanide dust in the destruction of the colonies.

The dust is blown into the colony through one or more openings until all the galleries are filled with the dust. Complete extermination has followed a number of such treatments. In some cases a second treatment has been necessary. The Harvester ant of the United States is being controlled by a similar method in a number of localities. In the latter cases, however, calcium cyanide flakes are being used rather than the dust. One or more holes are bored into the mound and an ounce or two of flakes dropped in. It has not been found necessary to close the holes after treatment.

V. I. SAFRO

Notes on the Feeding Habits of the Tarantula. Last July a local groceryman called up the laboratory stating that a tarantula had escaped from a bunch of bananas, so we went immediately and secured it. It was placed in a large glass jar with a cloth cover over the opening. From July 9th to August 4th it ate 10 large cockroaches, by actual count, and may have eaten several smaller ones. On several occasions it pounced upon the cockroaches just as soon as they were placed in the jar. One cockroach was apparently caught before it had time to reach the bottom. The tarantula is remarkably quick in its movements.

For several days prior to August 20th, it had not eaten anything and it moulted some time during the night of August 20th. Although cockroaches were placed in the jar at more or less irregular intervals subsequently to moulting, the notes do not indicate that any were eaten after this date. In all probability it was neglected and died about September 15th. No other insects were given to it during captivity.

W. W. YOTHERS, *U. S. Bureau of Entomology*

Another Mango Pest in the Philippines. In addition to the mango pests referred to in my previous note I have recently noted that the larvae of *Parasa lorquini* Reakirt,—so identified by Mr. W. Schultz, entomologist, Bureau of Science,—feed on the leaves of the mango. The larvae had devoured approximately 30 per cent of the leaves of a small mango tree about 2.5 meters high. It is the first time that I have seen this insect attack the mango during more than 13 years residence in the Philippines, so that it is probably of little importance as a mango pest in this country. This is probably due to internal parasites as many of the larvae were parasitized.

A related species, *Parasa lipida*, feeds on the leaves of the mango in India where it is said "to be a constant danger to young grafts and seedlings which they often completely defoliate." As a pest on the old mango trees they are said to be unimportant.

P. J. WESTER

Calcium Cyanide Dust for Control of the Grape Leaf Hopper. Calcium Cyanide dust was used in an experimental way against the Grape Leaf Hopper, *Typhlocyba comes* Say, by this Station in 1923 and again in 1924. From the previous work on this insect it appeared to the writer that if some effective method could be used against the over-wintering adult hoppers soon after they came onto the vine in the spring, that it would be the most desirable way to control the hoppers, but the adults showed great resistance to sprays or dusts heretofore used. The adult hoppers, on the other hand, proved to be susceptible to HCN gas. When the Calcium Cyanide dust is blown into the vine the hoppers are quickly overcome and fall to the ground. If there are no Cyanide particles on the ground the hoppers overcome by the gas will recover, but if there is a slight deposit of the cyanide on the ground sufficient gas will be given off to prevent the recovery.

On short pruned vines the method has been to use a knapsack duster by means of which the dust is shot into the vines from below and the heavier particles drop to the ground. Since the shoots of the vine at this season are only six to ten inches long, there is not much foliage to cover and a small amount of dust will do the work. Later in the season, when the second generation hoppers occur, Cyanide dust will also kill them, although a much greater quantity must be used. It is proposed to carry on work on a larger scale during the coming year, when more definite data will be secured as to the feasibility of controlling the Grape Leaf Hopper by Calcium Cyanide dust.

H. J. QUAYLE, *Citrus Experiment Station, Riverside, California*

COMMITTEE ON GENERAL ENTOMOLOGICAL TERMS

At the Cincinnati meeting the Entomological Society of America appointed a standing committee "to recommend for adoption by the Society a preferred usage respecting such general terms as appear to be current in conflicting and confusing forms." It will probably be agreed that we ought to have some uniformity in regard to the usage of such terms as brood, generation, larva, nymph, incomplete, gradual or simple metamorphosis, correct singular and plural forms of exuviæ and a host of others that are continuously used in conflicting or confusing ways. It is believed that a good purpose would be served by a full discussion of these terms, and if possible, an agreement by all members of the society to follow some one usage for certain ones of them. All who are interested are urged to transmit their suggestions at once to one of the members of the following committee: E. M. Walker, Chairman, University of Toronto, Ontario, G. C. Crampton, W. M. Wheeler, A. L. Melander, and A. L. Quaintance.

MEETING OF CONNECTICUT ENTOMOLOGISTS

The first conference or meeting of the entomological workers of Connecticut was held at the Agricultural Experiment Station, October 31, beginning at 10:00 o'clock A. M. Invitations were extended to all official entomologists, those teaching the subject in educational institutions, field foremen of State and Federal forces working within the State, amateur entomologists, graduate students, and official entomologists in adjoining states. About 58 attended this meeting, which was called to order by Dr. W. E. Britton, State Entomologist of Connecticut, who explained the purpose of the meeting and the program presented. He then called for the election of a Chairman. Dr. Britton was elected, and introduced Professor W. L. Slate, Jr., Director of the Station, who welcomed the visitors and assured them that the Station stands for service. Dr. Britton then gave a brief account of the entomological work of the Station. The office of State Entomologist was established by legislative enactment in 1901, on account of the menace of the San Jose scale, and was charged with the inspection of nurseries, of which there were only 25 in the State: last year there were 106. Later the control of the gipsy and brown-tail moths and the inspection of apiaries were placed in charge of the State Entomologist. In 1909, gipsy moth eggs and winter nests of the brown-tail moth were brought into the United States on nursery stock, so since then all imported nursery stock brought into Connecticut has been inspected. Though control work has always been an important part of the Department's activities, some research has always been conducted. Some of the best things accomplished are life history studies of the greenhouse white fly, maple leaf stem sawfly, peach sawfly, leopard moth, imported pine sawfly, walnut weevil, bulb mite, European red mite, spittle insects, apple and thorn skeletonizer and Asiatic beetle. Most of this work has been published in a series of 23 reports, containing more than 2,000 pages, and included in the annual reports of the Station. Some 33 bulletins containing over 600 pages have also been published, besides spray calendars and other papers in co-operation with other Departments of the Station. In addition to these publications, the Department has had charge of the preparation of the manuscript of four bulletins of the State Geological and Natural History Survey, totaling 2,200 pages, and the manuscript of a fifth is now ready for publication. The Department Library now contains more than 1,000 bound volumes, and more than 3,500 unbound bulletins and separates. The State insect collection con-

tains about 5,700 determined species, perhaps 5,000 specimens undetermined, and altogether more than 50,000 specimens. We have about 3,000 photographic negatives of insects and their work and about 800 lantern slides.

Professor G. H. Lamson, Jr., Professor of Zoology, Connecticut Agricultural College, Storrs, gave a brief account of some of his work on the parasites of poultry, cattle and sheep.

Mr. M. P. Zappe, Assistant Entomologist, Agricultural Experiment Station, New Haven, then gave an account of the Asiatic beetle, *Anomala orientalis* Waterhouse, which has appeared near a nursery in the western part of the city of New Haven, damaging lawns by eating off the grass roots. It was first collected in July, 1920, and in the fall of 1922, people in that vicinity began to complain of injury to lawns. Presumably it may have been introduced in balls of earth on nursery stock imported from Japan. Life history studies have not yet been completed, and we do not yet know whether the life cycle requires one or two years. Both cyanide and carbon disulphide emulsion were applied to the lawns, and in some instances each gave as high as 100 per cent. kill, but on account of the local conditions and the danger connected with the use of cyanide, we prefer the carbon disulphide emulsion. Most of the larvae are within two inches of the surface when feeding, but go deeper to pass the winter. The larva pupates in cells in the soil late in June, and the adults appear two weeks later. They do not fly much and are found rather close to the ground.

Professor J. A. Manter, Instructor in Entomology, Connecticut Agricultural College, Storrs, distributed an outline of the courses in Entomology given at the College, and described these courses briefly. Students taking entomology at the College fall into three groups: (1) short course of 20 weeks; (2) students in Agriculture, Horticulture, Forestry and Animal Husbandry, who need to know something about the insects which affect their crops and animals; (3) students specializing in entomology. The students of the third group are urged to take summer jobs where they can work on insect problems, thus acquiring practical experience.

Professor Alexander Petrunkevitch, Professor of Zoology in Yale University, referred to the general interest in entomology as manifested by attendance at meetings, yet it is one of the last subjects to be taught in American Universities. He related his experiences in teaching undergraduate entomology at Yale under somewhat trying circumstances. Students were required to identify insects by their structural characters. Formerly this course was required of all men preparing to enter the School of Forestry. Now it is no longer required.

Professor W. R. Coe, Professor of Biology in Yale University, explained his course in Forest Entomology at Yale. It consists of three-hour periods, and there are 20 exercises of laboratory and field work. The students are shown injuries to living trees, sawlogs and finished products, are taught to distinguish between injurious and beneficial insects and are made acquainted with methods in insect control. It is unfortunate that the course must be given in winter.

The subject of teaching entomology was discussed by Mr. A. F. Burgess, who emphasized the importance of practical field work in insect control. Such information cannot be obtained from books, and most of the men graduating from our institutions have only a theoretical knowledge. There seems to be a good opportunity for demonstrations and field practice at Storrs. The diffusion of knowledge cannot be restricted to a single center but must come from many different sources and from

different angles and viewpoints. He regretted that entomology has not had the opportunity to develop at Yale as at Cornell, Illinois and many other Universities.

Professor L. B. Crandall, Extension Specialist in Beekeeping at the Connecticut Agricultural College, Storrs, discussed the opportunities for beekeeeping in Connecticut. Most beekeepers practice beekeeping as a side line, and the older ones will not change their methods. The greatest hope for the future of the industry in Connecticut lies in interesting the younger men and women in the subject.

Mr. L. H. Worthley, Agent in Control of European Corn Borer, Bureau of Entomology, addressed the meeting on the discovery, spread and present distribution of the European corn borer in the United States. He explained the methods of control, quarantine enforcement, and how the Bureau of Entomology carries on this work in co-operation with the States which are infested. This infestation now includes all of the New England States, New York, Pennsylvania, Ohio and Michigan. Ontario, Canada, also has a large area infested just north of Lake Erie. Mr. Worthley showed these areas on a large map, and called attention to an exhibit of photographs and specimens in the rear of the hall.

Mr. Donald J. Caffrey, who has charge of the European Corn Borer Laboratory, maintained by the Bureau of Entomology at Arlington, Mass., spoke of the light infestations found along the Connecticut shore, and called attention to the fact that two generations occur annually at the Long Island infestation as in eastern New England, and the borers are found in both corn and weeds. In the infestations around Albany, and surrounding Lake Erie, there is only one brood of larvae, and they are found almost wholly in corn. The double-brooded borers attack 200 different plants, and they increase many times faster than the single-brooded insect. In Connecticut, much sweet corn is grown for seed. This is left for a long time in the field and if subject to two broods of borers, will be injured much more than by the one-brooded insect. In the dent corn belt of Hungary, where there is only one brood, there is seldom any injury to the ears, but all occurs in the stalks. This, however, affects the size of the ears. In regard to parasites, only slight parasitism is claimed by European writers, but since the Bureau established a laboratory for this purpose in France, Dr. Thompson has found eight or ten parasites present in appreciable abundance. These have been multiplied and liberated in this country. Some are 50 per cent. effective, and two have been recovered.

At 12:30 a recess was declared and nearly all went to the Yale Dining Hall and partook of a cafeteria luncheon, reconvening at 1:45 P. M.

Mr. R. B. Friend, Assistant Entomologist, Agricultural Experiment Station, New Haven, gave an account of his experience in trapping cabbage maggot flies during the past season. Though many different baits were tested, one of the most effective consisted of the residue left from a partial distillation of an alcoholic extract of the cabbage plant, mixed with honey, yeast and water. This was placed in the pans of Hodge fly traps distributed in the field perhaps twenty feet apart. In one experiment with 12 traps, 1841 female and 583 male flies were captured between May 16 and June 10. About 80 per cent. of the females contained eggs. The numbers given include two species, the cabbage maggot, *Hylemyia brassicae* Bouché, and the seed corn maggot, *Chortophila cilicrura* Rondani. There was only a slight infestation of plants by the cabbage maggot where the traps were used.

Mr. B. H. Walden, Assistant Entomologist, Agricultural Experiment Station, New Haven, in Hints on Photographing Insects, explained the development and

construction of lenses and the advantages of anastigmatic lenses over other types for scientific work. The most convenient outfit for photographing field operations is a small camera of the roll film type. The use of short focus lenses for laboratory photography was discussed, including micro-lenses for direct enlargements. He also mentioned the use of cut films in place of glass plates.

Mr. John T. Ashworth, Deputy in Charge of Gipsy Moth Work under the State Entomologist, with headquarters at Danielson, described the field work in suppressing the gipsy moth. Fifty-two towns were scouted and 21 others partially scouted last year by State men, besides some 25 towns along the border of the infested region which were covered by Federal scouts. Each crew is provided with a Ford light delivery truck in which they go to and from their boarding place. Egg-clusters are creosoted, and the worst infestations sprayed the following summer. This work is done in co-operation with the Federal Bureau of Entomology. Infestations are slight and scattered in Connecticut, and due to the control work, there has never been any stripping. In that part of the area longest infested, the gipsy moth is not as prominent as it was six years ago, and it is believed that the parasites are holding it in check.

Mr. A. F. Burgess, Melrose Highlands, Mass., who is in charge of the Federal gipsy moth work, referred to the satisfactory co-operation in this work between Federal and State forces, and called attention to the danger in the present conditions. People do not see damage and do not realize that the gipsy moth may again increase and therefore may not make adequate appropriations for the work. Ten years ago conditions in New England were certainly alarming. Now there is little stripping anywhere. Much research is necessary to develop the best control methods, and the quarantine regulations probably have prevented much dissemination of the pest. Parasites have been collected in Europe and other countries, reared in the laboratory and liberated in the infested area. The gratifying results now apparent should not be attributed wholly to the work of parasites. Creosoting, spraying and low temperature have all helped to reduce the pest and no man can tell whether this combination will continue. Mr. Burgess explained the barrier zone plan and gave a favorable report on the work of eradicating the pest in New Jersey.

Mr. Samuel S. Crossman, of the Parasite Laboratory in Melrose Highlands, Mass., gave an account of his recent trip to Europe in search of gipsy moth parasites, describing various conditions which he found there.

Dr. Philip Garman, Assistant Entomologist, Agricultural Experiment Station, New Haven, gave a history of the Oriental peach moth in Connecticut, and reported its increase and spread in 1924. The pest was discovered in Stamford in 1917, larvae were found there in 1918, but little trace of the insect was again seen until in 1923, when it caused serious injury to fruit in one orchard in Greenwich. In 1924, the damage was even greater and the pest occurred throughout the southwestern third of the State, and one report of wormy peaches came from central Connecticut near the Massachusetts line. The larvae winter in cocoon-like cases on the bark near the ground and probably emerge late in May or early in June; they first appeared in twigs at Greenwich about the middle of June in 1924. The first infested fruit was found July 14. There are probably three broods in Connecticut, the third hibernating. Eggs are laid on the leaves and hatch in from four to eight days. Adults fly actively late in the afternoon. The larvae often leave their twigs and enter other twigs or fruit. Cocoons are made anywhere on the tree or ground. One parasite has

been reared in Connecticut but not identified. Dr. Garman reported on nicotine sprays to kill the eggs as practiced in the Middle Atlantic States and mentioned his own experiments in Connecticut which gave only partial control.

Mr. R. C. Botsford, Deputy in Charge of Mosquito Elimination, Agricultural Experiment Station, New Haven, was the last speaker and gave a brief history of anti-mosquito activities in Connecticut, habits and life history of mosquitoes, and explained the work carried out during 1924, most of which was maintenance. Some new dikes were built and culverts and tide gates installed.

Messrs. Zappe, Friend, Walden, Garman and Botsford illustrated their talks by lantern slides.

There were a number of opinions expressed, all to the effect that the meeting had been a success and a hope that other meetings may be held in the future. The following were present: Mr. and Mrs. A. F. Burgess, A. F. Burgess, Jr., C. W. Collins, H. L. Blaisdell, S. S. Crossman, Melrose Highlands, Mass.; L. H. Worthley, D. J. Caffrey, R. A. Vickery, T. M. Cannon, Arlington, Mass.; Mr. and Mrs. Albert Hartzell, Yonkers, N. Y.; H. C. Huckett, Riverhead, N. Y.; H. J. Evans, Mineola, N. Y.; D. G. Murphy, Pittsfield, Mass.; H. A. Ames, Bound Brook, N. J.; Professors Alexander Petrunkevitch and W. R. Coe, Yale University, New Haven, Conn.; Professors G. H. Lamson, Jr., J. A. Manter, L. B. Crandall and A. J. Grady, T. F. Cronin, V. A. Johnson, J. W. Balock, Storrs, Conn.; F. C. Rich, Ansonia, Conn.; W. A. Collins, New Milford, Conn.; J. J. Pillsbury, Burnside, Conn.; Professor Pauline H. Dederer, Connecticut College for Women, New London, Conn.; S. E. May, Canaan, Conn.; P. H. Meagher, Wallingford, Conn.; John T. Ashworth, J. W. Longo, A. J. Gilbert, H. A. Woodmancy, H. E. Cook, O. B. Cooke, C. M. Spencer, Danielson, Conn.; Dolor LaBelle, Ballouville, Conn.; James A. McEvoy, Putnam, Conn.; A. W. Yates, Hartford, Conn.; H. W. Coley, Westport, Conn.; E. J. Smith, Clintonville, Conn.; Mr. and Mrs. Henry S. Woolley, Waterbury, Conn.; P. L. Buterick, New Haven, Conn.; Robert E. O'Brien, New Haven, Conn.; and Messrs. W. L. Slate, Jr., E. H. Jenkins, G. P. Clinton, E. M. Stoddard, G. E. Graham, Philip Garman, M. P. Zappe, B. H. Walden, R. C. Botsford, R. B. Friend, Leslie Rogers and W. E. Britton of the Agricultural Experiment Station, New Haven, Conn.

W. E. B.

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The editors will thankfully receive news matter and other items likely to be of interest to our readers. Papers will be published as far as possible in the order of reception, except that papers of reasonable length may be accepted in the discretion of the editor for early publication, at $3.00 per page for all matter in excess of six printed pages; in the case of other matter, the maximum of 2,500 words is still operative. Photo-engravings may be obtained by authors at cost.

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This issue has been delayed a little by the loss in the mails of a somewhat large sending of manuscript. It is the first experience of the kind which has befallen the editor in some seventeen years. Fortunately most of the lost matter had been duplicated by the Associate Editor and was therefore quickly available.

The recent appearance of pneumonic plague on the Pacific coast is a serious matter, though the earlier record of California in exterminating rats for the control of the bubonic form of this most dreadful disease gives assurance that no efforts will be spared to eradicate this most deadly affection. Unlike the bubonic type, the pneumonic form may be transferred from person to person, since the plague bacillus occurs in the sputum; consequently control is more difficult. There is no occasion for alarm. There is every reason to believe that the situation is being handled in the best possible manner, a protective serum even being shipped from the east by airplane. There were tremendous losses of life following the introduction of influenza and were it not for recent knowledge concerning plague and the methods of its dissemination, this latest introduction might mean a national disaster. National and state health officers fully appreciate the dreadful possibilities and we may rest assured that no stone will be left unturned in an effort to guard the health of the American people. In this connection, it is well to remember that the most serious human costs of wars have not been losses in the field nor even the losses from disease in armies, but those resulting from epidemics disseminated among the civil populations. A monographic account of these sequelae of wars, by Dr. Friedrich Prinzing,

was published by the Carnegie endowment for international peace in 1916. A number of the most deadly affections developing during wars or as a result of conditions following such disturbances, are disseminated by insects and assistance in controlling such therefore falls within the province of economic entomology, particularly that division known as medical entomology, a phase of applied science which has come rapidly to the front within recent years.

Review

An Introduction to Entomology by JOHN HENRY COMSTOCK. pp. i–xix, 1–1044, 1228 figures, First Complete Edition, Third Edition of Part I, Comstock Publishing Co., Ithaca, N. Y., 1924.

This is the long expected revision of the Manual for the Study of Insects which has been the standard with American entomologists for many years. It is really a re-written work with an added and extensive account of the structure and metamorphoses of insects, the latter published in a separate edition and now re-printed for the third time. The author's nearly fifty years of active study of insect life in its various phases, most of the time in positions where all that was best would come to him and with the large resources of a great university and its strong department of entomology at his command, has made possible a comprehensive, authoritative account of the structure and biology of American insects. The cooperation of the author's associates, especially Messrs. Bradley, Forbes, and Johannsen, has added materially to the value of the "Introduction." There is also an admirably selected bibliography. It is the work of a master, and bids fair to remain the standard treatise for many years to come.

E. P. FELT

Current Notes

Messrs. Geo. A. Dean and L. H. Worthley called at New Haven, Conn., October 17, on a trip to visit the European corn borer infestations.

Dr. William Colcord Woods, formerly instructor in biology, Wesleyan University, Middletown, Conn., resigned since the close of the college year to accept a position at Kent School, Kent, Conn.

Dr. F. A. Fenton, of the Bureau's boll weevil laboratory at Florence, S. C., visited the Baton Rouge, La., laboratory during the middle of September and conferred with Bureau and State officials.

Mr. George N. Wolcott, of Hayti, recently called at the Division of Insects, U. S. National Museum, bringing with him specimens to have identified, and consulted the specialists regarding some of his taxonomic work.

Dr. Mortimer D. Leonard, formerly associate State Entomologist of New York, has returned to the United States after spending three months in Spain where he studied methods of combating the Mediterranean fruit fly.

Dr. H. H. Knight, curator of insect collections of the University of Minnesota, University Farm, St. Paul, Minn., has resigned to accept a similar position at the Iowa Agricultural College and Station at Ames, Iowa.

Messrs. Stewart Lockwood and F. W. Boyd, of the Billings, Mont., laboratory of the Bureau of Entomology, attended the conference of the Northwest International Committee on Farm Pests, held at Bozeman, Montana, August 27 and 28.

Dr. J. M. Swaine, Entomological Branch, Canadian Department of Agriculture, was admitted to the hospital on August 10 and successfully operated on for appendicitis. He is convalescing most satisfactorily.

Prof. A. F. Conradi, for many years professor of zoology and entomology at the Clemson Agricultural College, entomologist of the South Carolina Experiment Station, and State Entomologist, has resigned to enter the field of commercial entomology in South Carolina.

Messrs. J. S. Houser, L. L. Huber and C. R. Neiswander of the Ohio Station recently accompanied a party of entomologists on an inspection of Canadian corn fields. The increase in borer infestation was very pronounced and considerable damage is being done.

At the forty-ninth annual meeting of the Georgia State Horticultural Society, held at Griffin, Ga., August 6, Mr. Oliver I. Snapp of the Bureau of Entomology gave an address on the year's development in the control of peach insects.

Messrs. Nicolai, Shoemaker and Quersfeldt, of New York, recently spent a week doing miscellaneous collecting in the vicinity of Washington and visited the Section of Insects, U. S. National Museum, to meet the members of its force and consult with the coleopterists.

According to *Science*, Dr. Vernon Kellogg has been appointed by the Department of State as one of the official representatives of the United States to the third Pan-American Congress to be held at Lima, Peru, from December 20 to January 6.

The entomological laboratory of the Bureau of Entomology at Ritzville, Wash., in charge of M. C. Lane, has been moved to Toppenish, Wash., a location believed to be more advantageous for the co-operative studies on the wireworms injurious to potatoes, wheat, and other crops.

Dr. F. H. Lathrop of the New York (Geneva) Agricultural Experiment Station, recently of the field station at Poughkeepsie, has been appointed State Entomologist of South Carolina, entomologist of the Station and professor of zoology and entomology in Clemson College, vice A. F. Conradi, resigned.

A list of corrections and additions to the "Hemiptera of Connecticut," Bulletin No. 34, Connecticut Geological and Natural History Survey, has been printed. Anyone who has received Bulletin 34 may obtain the list by applying to Mr. Geo. S. Godard, State Librarian, Hartford, Connecticut.

Mr. David Dunavan, temporarily in charge of the Toppenish, Wash., truck crop laboratory of the Bureau of Entomology, attended the meeting of horticulturists, pathologists, and entomologists, held at Penticton, B. C., but has now returned to the Oregon Agricultural College to complete work for his degree.

Mr. Fred M. Schott of Brooklyn, N. Y., recently in the service of the State of New Jersey, was for a week, while in Washington, a frequent visitor to the Division of

Insects, U. S. National Museum, and brought with him a number of insects for identification by the specialists.

Mr. William Schaus of the U. S. National Museum, went to Pittsburgh toward the end of September to consult with Dr. Holland, examine types in the Carnegie Museum, and return material which had been sent him for study. Mr. Schaus has recently completed a paper on certain African Lepidoptera.

The Sugar Cane Insect Laboratory of the Bureau of Entomology at New Orleans, La., was moved September 29 to rooms 6 and 7, Wilson Building, 8,200 Oak Street, New Orleans. The new location is one block above Carrolton Avenue and can be reached by St. Charles and Tulane Belt cars.

At the Entomological Branch, Canadian Department of Agriculture, the following resignations have been announced: Mr. G. S. Walley, Seasonal insect pest investigator and Fred P. Ide, seasonal laboratory assistant, to attend the University of Toronto: Misses Forward and M. Bonell, the former to continue her studies at the University of Toronto.

Mr. D. J. Caffrey, in charge of the corn borer investigational work of the Bureau of Entomology made a tour of inspection throughout the infested area during the latter part of August, spending several weeks visiting and inspecting the various laboratories and the more recently infested sections of the Lake district.

Mr. Fred E. Brooks in charge of the French Creek, W. Va., laboratory of the Bureau of Entomology, discussed the more important insects attacking nuts and nut trees in the northern states before a meeting of the Northern Nut Growers Association, held at the Botanical Garden, New York City, September 3–5.

Transfers in the Bureau of Entomology have been announced as follows: T. C. Barber, from sugar cane insects to cotton hopper, Brownsville, Tex.; S. C. Brummitt, from Silver Hill to Grand Bay, Ala., sweet potato weevil eradication; C. H. Popenoe, from Silver Spring, Md., to Washington, D. C.; J. C. Shiver, Melrose Highlands, Mass., to Columbia, S. C.

The following appointments to the Bureau of Entomology have been made recently: Leslie W. Orr, temporary field assistant, St. Paul, Minn.; Curtis Benton, stored product insect investigations, Fresno, Calif.; Wallace Coleman, Junior entomologist, bean beetle work, Birmingham, Ala.; Walter Baldwin, Riverside, Calif.; L. P. O'Dowd and Daniel D. Ewing, Jr., temporarily, during October, November and December, La.

Mr. William Middleton of the Bureau of Entomology recently returned from New York where he met the Fabre Liner *Providence*, on which was a shipment of parasitized elm leaf-beetles from Dr. W. R. Thompson in France. An attempt is to be made to establish the dipterous parasite, *Erynnia nitida* R. D., of the elm leaf-beetle in this country.

Dr. H. C. Fall, the well-known Coleopterist of Tyngsboro, Mass., visited Ottawa in early August on his return from an Alaskan trip and spent a day studying the Coleoptera in the National Collection. He expressed himself as much impressed by the excellent showing of the collection and promised to help in any way possible to add to its completeness.

Mr. Leonard S. McLaine, accompanied by Mrs. McLaine, returned to Ottawa from their trip to England on Saturday, August 2. While in England, Mr. McLaine

attended a very interesting Imperial Conference, called by the British Ministry of Agriculture and Fisheries, to consider Imperial Legislation in connection with the exchange of plants and plant products throughout the Empire. This conference was held on July 17.

Entomological News records the death of the following entomologists: Philippe Grouvelle, August 2, 1923; Jules Grouvelle, November 6, 1923, both coleopterists of France; Edmond Bordage (date not given) also of France; Charles Oberthur, the great lepidopterist, June 1, Rennes, France; Frederick Merrifield, May 28, 1924, Brighton, England, a lepidopterist; Dr. David M. Castle, a coleopterist and member of the Feldman Collecting Social, Philadelphia, August 6, 1924.

Mr. H. L. Viereck, who was definitely appointed to the position of assistant entomologist in the Division of Systematic Entomology, Canadian Department of Agriculture, on August 1, has marshalled all of the Hymenoptera in the National Collection so that it is now possible to tell when one looks at a species, whether all the available material is at hand. Mr. Viereck has also made considerable progress in the listing of Canadian Hymenoptera and the work is nearing completion.

Mr. M. J. Forsell of Everett, Washington, has recently been appointed junior plant quarantine inspector with the Federal Horticultural Board, and stationed at Seattle, Wash. Previous to this he was horticultural inspector with the State of Washington Department of Agriculture where in addition to his usual duties, he made a special study of the strawberry root weevil, working out the life history and making special migration studies. This pest is the most puzzling problem of all among the berry growers of the Puget Sound region.

Prof. W. M. Wheeler of Harvard University has sent to the U. S. National Museum paratypes of an extraordinary larval myrmecophile which he collected in Panama and recently described as *Nothomicrodon aztecarum*, new species. They are very small insects with no legs and few organs, shaped like a little bag or flask with the head sticking out at one end. It is supposed that they belong to the Diptera, but it is impossible to tell with any certainty to what family, as no one has previously found anything like them.

Mr. C. N. Ainslie, entomologist, in charge of the Sioux City laboratory of the Bureau of Entomology, visited Beach, N. D., during August, to investigate a severe infestation of the Hessian fly in western North Dakota, where he found the insect more abundant and injurious than for many years. He gathered valuable notes relating to the insect and its parasites in an unusual environment. He also planned a trip to northeastern Montana to confer with Dr. J. R. Parker of the Montana Experiment Station concerning the new infestation of Hessian fly in that State.

Captain Bartlett, who commanded the vessel "Roosevelt" on Peary's expedition to the North Pole, called on Dr. Aldrich at the U. S. National Museum, October 1, to clear up some questions concerning specimens collected on the expedition. The specimens had been previously sent to the Museum in pill boxes, with only the date and locality of collection. It is believed that as a result of this conference with Captain Bartlett more information will be available, the specimens will be of more value, and a more accurate record will be preserved of the entomological results of the expedition.

Prof. Geo. A. Dean returned to Washington September 16 from an extensive trip to several of the entomological laboratories of the Division of Cereal and Forage Crop

Insects, located in the Northwestern, Central, and Southern States. While in the Northwest he attended the conference of the Northwest International Committee on Farm Pests, held at Montana Agricultural College, Bozeman, August 27 and 28. Prof. Dean reports a decided improvement in the grasshopper situation in the Northwestern States. The loss by grasshoppers during the past season has been very much less than that of the years 1922 and 1923. He also reports splendid results by the entomologists of the Billings, Mont., laboratory in the control of the Mormon cricket with the poisoned bran mash and by the entomologists of the Salt Lake City laboratory in the control of the alfalfa weevil with arsenical dust.

The following resignations from the Bureau of Entomology have been announced: L. B. Sanderson, field assistant in insect control, cereal and forage crop investigations; Bruce Lineburg, bee culture investigations to accept a position as instructor in Lake Forest University; E. W. Tschudi, bee culture laboratory, to resume his work at Johns Hopkins University; W. B. Wheelis, bean beetle work, Birmingham, Ala.; S. T. Howard, mechanical engineer, boll weevil laboratory, Tallulah, La.; C. P. Barber, R. M. Foster, H. S. Hollingsworth, J. M. Hyman, LeRoy Johnson, J. G. Lewis, E. E. Lumpkin, L. G. McGraw, D. A. McIntosh, A. H. McMullen, B. J. Nuckols, P. J. Pace, R. A. Robinson, J. G. Sevier, F. A. Smith, P. E. Stephens, J. C. Wilkerson and R. D. Williams of the Southern Field Crop investigations; B. E. Montgomery, field assistant, Vincennes, Ind., for graduate study at Purdue University; H. L. Weatherby, Ala.; L. M. Bertholf, bee culture investigations, to accept an instructorship in biology at Western Maryland University; Carlton Burnside, bee culture investigations, to resume graduate study, University of Michigan: Samuel Blum, Junior Entomologist, Columbia, S. C.

Since the latter part of July a staff of thirty-five men has been engaged on Canadian gipsy moth work and all territory along the border is being examined. The first record of the gipsy moth in Canada was taken by Mr. A. K. Gibson, Crew Foreman, on July 29 near the town of Stanstead in Stanstead County. A very serious infestation was also found by Mr. A. Magnan, Crew Foreman, on September 3 about four miles southwest of Lacolle Village in St. John's County, and investigations have shown that this outbreak is at least three years old. Scouting carried on to date shows that the infestation extends over an area of at least six hundred yards square. Although a comparatively small number of trees are included in the infestation, clean-up work will be greatly handicapped on account of the presence of many stone walls situated on the infested properties, and the large number of egg-masses within these walls. Egg-masses were also discovered on and within the various farming buildings.

At the Ohio Agricultural Experiment Station, Wooster, the new chemical and biological building, known as Thorne Hall, will be ready for occupancy about the first of January. The entomological department will occupy the second floor of the east wing of the building, and the quarters include a library and collection room in the northeast corner of the building, fronting the north. This room is 36′ x 14′, has 5 windows to the north and two to the east. A hallway five feet wide runs the length of the east wing and through the center of the wing. East of the hallway is an outfit of five offices, the office of the Chief, next to the library, being 20′ x 12′, with three windows to the east. Then comes a series of four offices, each 11′ x 12′, and each having two windows to the east. Then comes a small office or storeroom, 8′ x 12′, with one window to the east. At present it is planned to use this as a storeroom for

chemicals and as a preparation room for museum material. Extending across the south end of the wing is a laboratory 30′ x 16′. It has two windows to the east, four to the south and two to the west, being splendidly lighted. This will be equipped with tables, electric ovens, water, sink, etc. On the west side of the hall-way is a museum and collection room, 33′ x 16′, with six windows to the west. It is planned to use this for economic exhibits, life history displays, and such museum material as will interest and instruct visitors. The systematic collections and Schmitt boxes will probably be kept in the library room. In the basement there is a large room extending the width of the entire wing, 25 or 30 to 40 feet in depth, in which can be stored insecticides and heavy material and types of spraying machinery for the education and instruction of the public. At a short distance from these quarters a greenhouse and insectary will be constructed within a year or two.

The foreign gipsy moth (*Porthetria dispar* L.) parasite investigations have been continued during the season of 1924. Messrs. S. S. Crossman, R. T. Webber, and S. M. Dohanian went to Europe in the latter part of February in search of gipsy moth parasites for introduction into the infested area of the United States. After spending a few days at Paris, interviewing several entomologists, Messrs. Crossman and Dohanian proceeded to Spain, and Mr. Webber went to Poland and Hungary. Several medium to heavy gipsy moth infestations were visited in Spain, and through the kindness of Dr. M. Aullo, Director of the Laboratory of Forest Fauna of Spain, arrangements were made to use two of his field stations for the season. Mr. Dohanian remained in Spain during the season to carry on the investigations. Messrs. Crossman and Webber spent most of the season in Poland, Hungary, Yugoslavia and Bulgaria. After finding suitable infestations in each of these countries, temporary field laboratories were established. In addition to these countries, parts of Rabat and Algiers in northern Africa, France, Austria, Germany, Roumania, Czecho-Slovakia, Sardinia and Sicily were searched for *P. dispar* infestations. No infestations of suitable size for parasite introduction work were found in the latter-named countries, excepting in Algiers and Rabat. Arrangements were made at Algiers to have shipments of gipsy moth larvae sent to Melrose Highlands during the season. At Rabat a heavy infestation was found, and Dr. Liouville, Director of the Institute Scientifique Cherifien, planned to have a study of the parasties of *P. dispar* made at Rabat this summer. Should this investigation show any valuable gipsy moth parasites present which have not already been introduced into America, arrangements can be made to carry on such work. During the spring and summer about 85,000 tachinids were sent to Melrose Highlands. Of these importations, about 50,000 are *Parasetigena segregata* Rond., and 19,000 *Blepharipa scutellata* R. D. These two species have only one generation each year, and they have been placed in hibernation at the laboratory. The remaining material is composed of species having more than one generation annually, and in most cases the adults had issued and died before reaching Melrose Highlands. The species involved are *Sturmia gilva* Hartig, *Carcelia gnava* Meig., *Compsilura concinnata* Meig., and *Tricholyga grandis* Zett. In addition a few specimens of *Chalcis intermedia* Nees, and a few cocoons of a species of Hyposoter, *Apanteles fulvipes* Hal., *A. vitripennis* Hal., *A. melanoscelus* Ratz., were sent to Melrose. Also about 1,000 adults of *Carabus* sp., Reiche and a few *Calosoma inquisitor* L. were sent to the laboratory. A few adults of *Silpha quadripunctata* L. were shipped, but all were dead when received in the States. S. S. Crossman and S. M. Dohanian returned to the Gipsy Moth Laboratory in August and R. T. Webber early in September.

Horticultural Inspection Notes

Mr. R. K. Beattie of the Federal Horticultural Board recently returned from an extensive inspection trip in the Northern and Western States.

Mr. F. A. Johnston, Plant Quarantine Inspector of the Federal Horticultural Board has been transferred from Washington, D. C. to El Paso, Texas.

Mr. H. H. Willis has resigned his position as Associate Plant Quarantine Inspector in charge of the activities of the Federal Horticultural Board at El Paso, Texas.

Two shipments of Spanish grapes arriving in New York recently were found to be infested with the Mediterranean Fruit Fly. Both of the consignments were refused entry.

St. Louis has been made a port of entry for plant material, and Mr. H. A. Horton, who formerly served in the capacity of Plant Quarantine Inspector at Seattle, Wash., has been placed in charge.

Mr. O. D. Deputy, Plant Quarantine Inspector in charge of the work of the Federal Horticultural Board at Brownsville, Texas, recently visited the various ports on the Mexican Border for the purpose of co-ordinating the work.

The Federal Horticultural Board has established an office in Chicago, and Mr. L. M. Scott, who has been stationed at Boston in the capacity of Plant Quarantine Inspector, was transferred to Chicago to take charge of the work.

At the request of nurserymen interested in the subject, a conference was held at Washington on Nov. 26, 1924, for the purpose of considering the desirability of revising the Federal "White Pine Blister Rust" Quarantine No. 26. The conference was well attended by nurserymen and State and Federal officials.

Mr. H. L. Sanford of the Federal Horticultural Board has been investigating fruit fly conditions in Cuba and the Isle of Pines. He was accompanied by Mr. Warner of the Florida State Plant Board on his first trip, and on the second trip by Mr. Moznette of the Bureau of Entomology.

Oranges coming from the Argentine Republic, affected with brown spots, were recently intercepted in ship's stores at New York City by inspectors of the Federal Horticultural Board. An examination of the fruit sent to Washington showed it to be attacked by a disease somewhat similar to the Citrus scab, which is already in this Country. The disease found, however, is quite distinct and was not recognized as one which is known here.

Mr. L. A. Strong, in charge of Port Inspection with the Federal Horticultural Board, has returned from a trip to the Southern Ports. While in the South he visited Charleston, Savannah, Jacksonville, Miami, Key West, Tampa, Mobile, New Orleans, and Galveston, to study shipping conditions at these places, with a view of making improvements in the inspection service. He addressed a meeting at the Florida Agricultural College in Gainesville, in connection with their Farmers & Fruit Growers Week.

Dr. W. M. Mann of the Bureau of Entomology has been investigating the Mediterranean Fruit Fly situation in Spain, Portugal, Southern France, and other Mediterranean regions, for the Federal Horticultural Board, in order that definite information might be available in regard to the danger of introducing this insect and other serious pests with importations of fruit. The investigation has been completed, and Dr. Mann will return to the United States shortly.

Mr. R. S. Hawkins, temporary Insect Pest Inspector at Fredericton, N. B., Laboratory, resigned on September 8.

Mr. Alfred Lutken, a graduate of the Agricultural and Mechanical College of Mississippi, has been appointed Plant Quarantine Inspector for duty at the Honolulu, Hawaii, station. Mr. Lutken has had two years' experience as Assistant Inspector for the State Plant Board of Mississippi.

A staff of four inspectors is now engaged in the examination of vegetables shipped from the Windsor district to the United States, and up to July 12, certificates were issued for the export of beets and beans to the value of $10,000.00 and oat straw grown in various parts of the province, amounting to the value of about $1,500,000.00.

On July 1, a Regulation was passed by the Federal Horticultural Board prohibiting the export of Christmas trees from all townships along the international border in southern Quebec, on account of the danger of spreading the Gipsy Moth to uninfested portions of the United States. The protection of the balance of Quebec and Canada has also been provided for through a Domestic Quarantine which was passed on September 3 as Regulation No. 7, placing an absolute quarantine on the bordering townships in southern Quebec covered by the United States Regulation and also placing under restriction the townships adjoining this area on the north and west, which prohibits the movement of Christmas trees from this area unless accompanied by a certificate of origin issued by this Department. To date a total number of 5990 permits have been issued to cover shipments of nursery stock from the United States and a total number of 4153 permits to cover importations from other countries.

Apicultural Notes

The fall meeting of the Connecticut Beekeepers Association was held in Hartford, October 25.

The annual meeting of the Georgia Beekeepers Association was announced for October 29–30 at Savannah. Mr. L. C. Walker, Alma, Ga., is Secretary of this organization.

The annual meeting of the Alabama Beekeepers Association was scheduled to be held in the Chamber of Commerce Auditorium, Montgomery, Ala., on November 6. Mr. M. C. Berry is Secretary.

Announcement was made of the annual meeting of the Northern Illinois and Southern Wisconsin Beekeepers Association on October 21 at Freeport, Ill. Mr. B. Kennedy, Rockford, Ill., is the Secretary.

About 250 people from the United States, Canada, and Europe, attended the Seventh International Apicultural Congress held at Quebec, September 2 to 4. The Bureau of Entomology was represented by E. F. Phillips and James I. Hambleton.

Mr. W. J. Nolan of the Bureau of Entomology attended the meeting of the North Carolina State Beekeepers' Association at Winston-Salem, September 10. Messrs. E. S. Prevost and C. L. Sams, formerly extension workers with the Bureau, but each now engaged in similar work for South Carolina and North Carolina respectively, were also present.

Included among the visitors at the Bee Culture Laboratory of the Bureau of Entomology during the month of October were: Dr. E. F. Phillips, now Professor of

Apiculture in Cornell University; Mr. George S. Demuth, editor of *Gleanings in Bee Culture;* Mr. Robert Dumn, art editor of *Farm and Fireside;* Mr. M. S. Smith, rehabilitation worker in beekeeping at the University of Indiana; and Mr. Ph. J. Baldensperger, the French delegate to the recent International Apicultural Congress at Quebec.

Mr. Baldensperger has an international reputation as an authority on beekeeping, especially as to races of bees. He has had an exceptional opportunity to make investigations along this line, both because of extensive travels in northern Africa in quest of native races of bees and because of many years of experience in beekeeping in Palestine and France. As a result of his experience with many different races, Mr. Baldensperger believes that a certain race native to the Sahara, which he calls the Saharan race, is equal to or better than any other race he has dealt with. Mr. Baldensperger is also editor of the *Bulletin de la Société d'Apiculture des Alpes Maritimes*, besides being known as a writer on archaeology and affairs dealing with Palestine. During his visit in Washington he delivered lectures at the Bee Culture Laboratory, at the Rhode Island Avenue Presbyterian Church, and before the Biological Society of Washington.

The paper by Dr. A. P. Sturtevant of the Bee Culture Laboratory, of the Bureau of Entomology entitled "The Development of American Foulbrood in Relation to its Causative Organism," appeared in a recent issue of the *Journal of Agricultural Research*. According to Doctor Sturtevant the larval intestine before the seventh day contains so large a percentage of reducing sugar as to inhibit the growth of *Bacillus larvae*. By the seventh day, however, the concentration of this sugar becomes reduced sufficiently to allow active growth of *Bacillus larvae*. This explains why American foulbrood occurs for the most part only during the later stages of larval development.

Acarapis woodi is being found to be more widely distributed than was generally believed at first. It has now been found in apiaries of the German-speaking portion of Switzerland, as well as around Salsburg, Austria. Dr. Enoch Zander, of Germany, who examined the latter outbreak on the spot during the past summer, states that it is far from being a sporadic occurrence. Doctor Zander recently published a comparison of the disease caused by *Acarapis woodi* and that caused by *Nosema apis*. Speaking for conditions in Europe he says that these two parasites cause losses which are out of all comparison to those caused by brood diseases. Doctor Zander, it will be recalled, was the first to describe the protozoan causing the Nosema disease. Owing to the discovery of *Acarapis woodi* in adjacent central European countries, Germany has followed the lead of the United States in prohibiting the importation of bees whether on combs or not. The importation of used hives is also prohibited.

Mr. L. M. Bertholf, who was engaged in a study of the development of the honeybee larvae at the Bee Culture Laboratory of the Bureau of Entomology, has resigned his temporary appointment to accept a position as Instructor in Biology at the Western Maryland University. He is also continuing graduate work at Johns Hopkins University.

All those interested in beekeeping who attend the coming meeting of the American Association of Science at Washington are invited to visit the Bee Culture Laboratory of the Bureau of Entomology on Tuesday, December 30. At this time the various phases of the work now being conducted at the Laboratory will be fully demonstrated.

This will include an exhibition of the instruments used in obtaining internal humidity and temperature records of the hive, an exhibition of over four hundred samples of honey from all sections of the country, the spectro-photometer or instrument used in an attempt to establish color grades for honey, the special photographic apparatus used in obtaining records of brood development, the various bacteriological methods used in determining diseases, specimens of *Acarapis woodi*, as well as other things of interest.

Alertness by the Mississippi State Plant Board in the forepart of the year prevented a possible outbreak of American foulbrood when a beekeeper from another State moved a truckload of bees into one of the best honey-producing counties of Mississippi without proper authority. His action came to the attention of the Board almost immediately, however, and resulted in destruction of the apiary.

R. B. Willson, extension worker in charge of beekeeping for New York State, has equipped an automobile for demonstrating the use of the Hutzelman alcohol-formalin method for treating combs infected with American foulbrood.

Several interesting beekeeping books have appeared recently. One of these, "Law of the Honeybee," published by The American Honey Producers' League, aims to give all court decisions affecting beekeepers' rights. Two beekeeping books have appeared from England, one entitled "Beekeeping for Beginners" by I. H. Jackson, and the other "Practical Beekeeping" by Arthur M. Sturges. Rev. Ivan F. Kitzberger of Czechoslovakia, editor of a journal devoted to scientific apiculture, has published a book, "Rostliny Medonosné," which gives in Czech a description of all the honey-plants found in the author's country, the Latin equivalents being given for all generic and specific names, and the German equivalents for all generic names.

Among recent state bulletins is that by Russell H. Kelty, entitled "Seasonal Management for Commercial Apiaries," published as Special Bulletin No. 135 of the Agricultural Experiment Station of Michigan Agricultural College. In August, Texas issued a reprint of its bulletin No. 255, "Beekeeping for Beginners."

As a publication of the Czechoslovak Ministry of Agriculture, Dr. Ot. Laxa has prepared a 116 page report on Czechoslovak honey. One section of the work is devoted to the results obtained from a chemical analysis of 166 different samples of honey from the author's country.

To settle a controversy as to which comb-honey granulates more quickly, that from the West or that from the East, beekeepers asked the Bee Culture Laboratory to take up a study of the rate of granulation in comb-honey from all sections of the country. To provide the Laboratory with samples of comb-honey for this purpose, beekeepers in several regions of the country have already sent specimens of their crop, and it is hoped that enough more will do likewise so as to have every portion of the country represented.

For some time Europeans have been more zealous in an attempt to better their bees by breeding than has been true of beekeepers in the United States. The co-operative methods employed for maintaining mating stations by beekeepers in Switzerland, Czechoslovakia, Germany, and Austria are known to all who read the beekeeping journals of Continental Europe. To most American beekeepers the term "mating station" is unknown. In recent months European workers in this field have been laying much emphasis on the fact that honey-gathering qualities should be considered of first importance, and that only secondary importance should be attached

to color, gentleness, non-swarming, and the like. Various strains of bees in the countries concerned are being developed by selective breeding under qualified supervision.

The following schedule of beekeeping meetings has been announced by the American Honey Producers' League: November 5–6, Portland, Oregon; November 6–8, Thermopolis, Wyoming; November 11–12, Denver, Colorado; November 14, Omaha, Nebraska; November 15, North Platte, Nebraska; November 18–19, South Dakota; November 20–21, Fargo, North Dakota; December 4–5, Madison, Wisconsin; December 9–10, Springfield Illinois; December 10–11, Lansing, Michigan; December 15–16, St. Paul, Minnesota; December 17–18, Des Moines, Iowa, and December 19–20, Montana. In addition to the above meetings, various state beekeeping associations will hold meetings as follows: January 8, Cambridge, Maryland; January 21–22, Pennsylvania; last week in January, Nashville, Tennessee; and February 5–6, Columbus, Ohio. Cornell University plans a short course beginning January 26, and Purdue University a short course during the middle of February.

Notes on Medical Entomology

The small species of predaceous fish, *Gambusia affinis*, imported recently from the States as a means of controlling mosquitoes, is reported by Mr. E. Hearle as thriving in the sulphur waters of Banff Springs.

The occurrence of a case of yellow fever in Houston, Texas, during October caused some temporary excitement; however, prompt diagnosis and immediate isolation of the case prevented any further spread of the disease even in the presence of a fairly abundant supply of yellow fever mosquitoes, *Aedes egypti.*

Miss Clara S. Ludlow of the Army Medical Museum, whose work on disease bearing mosquitoes has given her a distinguished place in the field of science, died in Washington, D. C., September 28, at the age of 70 years. Miss Ludlow discovered and described many new species of mosquitoes.

In connection with the Mosquito Investigations at Banff, Alta., a shipment of 600 fish of the species *Gambusia affinis* were sent to Mr. Eric Hearle on July 25. They arrived in excellent condition. They were forwarded through the kindness of Mr. L. G. Lenert, Sanitary Engineer, Sacramento Board of Health, Sacramento, California. This experiment of introducing fish which are predaceous upon mosquito larvae, will be watched with interest.

A few cases of dengue fever have occurred in Texas during the fall, but there has been no tendency for the malady to become widespread. The carrier of the disease, *Aedes egypti*, has been present in numbers rather above the average for this time of the year. It is probable that the large percentage of immunes is partially responsible for the comparative small number of cases this year.

During July, W. E. Dove of the United States Bureau of Entomology, began investigations of the human affliction known as "Larval Migrans," with headquarters at Jacksonville, Florida. This work was undertaken at the urgent request of Dr. J. Lee Kirby-Smith, one of the leading dermatologists of the South, who has been familiar with this malady in his practice for the past fourteen years. The entomological aspects of the work are being conducted by Mr. Dove under the general supervision of F. C. Bishopp. During the latter part of July a clinic was opened in Jack-

sonville in co-operation with the city and state boards of health. During the two weeks of this clinic one hundred and eighty-five patients infested with "Larval Migrans" presented themselves for treatment and gave case histories. This material is serving as a basis for a thorough epidemiological study of the malady. So far the causative organism has not been isolated and indications are that it is not the larva of an insect as was at first supposed. In addition to these studies, Mr. Dove is carrying on biological work in Florida with the Tabanidae.

The Connecticut Anti-Mosquito Association held an institute at the Agricultural Experiment Station, New Haven, Conn., on the afternoon of November 7. Among the speakers were Professor W. L. Slate, Jr., Director of the Station, Dr. W. E. Britton, State Entomologist, Mr. R. C. Botsford, Deputy in Charge of Mosquito Elimination, Dr. Stanley H. Osborn, Health Commissioner, Mr. George J. Bassett, President, New Haven Chamber of Commerce, and Messrs. H. H. Chapman, W. O. Filley and A. V. Parker, representing the State Park Commission. Mr. Malcolm R. Pitt, President, presided, and about 30 were present. A definite program for anti-mosquito work in the State was considered and will probably be placed before the next session of the legislature.

Pacific Slope Notes

Mr. Kenneth A. Salman has recently accepted a position as entomologist for the government of San Salvador. His work will be under the direction of Prof. Frederic W. Taylor who is Director General de Agricultura for that government.

According to *Science*, Mr. E. P. Van Duzee, curator of entomology, California Academy of Sciences, has returned from southern Arizona, where he and his assistant, Mr. J. O. Martin, spent six weeks collecting Hemiptera and other insects. He brought back about 15,000 specimens to enrich the Academy collections.

Mr. M. A. Yothers of the Bureau of Entomology, with headquarters at Yakima, Wash., made two official trips to the Puget Sound country during the summer to investigate the Narcissus bulb flies, *Merodon equestris* Fab., and *Eumerus strigatus* Fallen. It was found that these two flies are very abundant and injurious to Narcissus bulbs throughout the entire Sound region. Mr. Yothers also made a trip to South Idaho during August at the request of the Idaho State Department of Horticulture, to investigate the unprecedented injury to prunes by tree crickets, *Oecanthus* spp., which were eating the prunes to such an extent that they caused hundreds of thousands of dollars loss to the prune growers.

At the Pan-Pacific Food Conservation Conference held at Honolulu, H. I., July 31 to August 14, the following Entomologists were present: Doctors L. O. Howard and C. L. Marlatt, U. S. Bureau of Entomology, Washington, D. C.; Dr. T. D. A. Cockerell, University of Colorado, Boulder, Colo.; Dr. Royal N. Chapman University of Minnesota, St. Paul, Minn.; Dr. Herbert Osborn, Ohio State University, Columbus, Ohio; Dr. Wm. B. Herms, University of California, Berkeley Calif.; Roy R. Reppert, Extension Entomologist, Texas.

The Sixth Annual Meeting of the Northwestern Association of Horticulturists, Entomologists, and Plant Pathologists, was held at Penticton, B. C., August 26–29, 1924. There was a varied program of general horticultural interest, and the entomological section of it included discussions of oil sprays, grasshoppers, wireworms,

strawberry weevils, and of methods of combating certain forest tree insects. The program was concluded with a luncheon served on the grounds of the Dominion Experimental Farm at Summerland, B. C., an inspection of the Farm, and a trip through the orchard sections of the Okanagan Valley. This organization is by no means as formal as the length of its name would indicate. Its chief purposes are to afford its members the opportunity of becoming better acquainted with each other, and of getting the other fellow's ideas about one's own particular problem. Over 75 members attended the meeting, including the following entomologists: Leroy Childs, Hood River, Ore.; N. L. Cutler, Vernon, B. C.; W. Downes, Victoria, B. C.; D. Dunavan, Toppenish, Wash.; Arthur Gibson, Ottawa; Eric Hearle, Banff, Alta.; Geo. R. Hopping, Vernon, B. C.; M. C. Lane, Toppenish, Wash.; A. L. Melander, Pullman, Wash.; E. J. Newcomer, Yakima, Wash.; Max M. Reeher, Forest Grove, Ore.; Max Ruhman, Vernon, B. C.; B. J. Thompson, Corvallis, Ore.; E. P. Venables, Vernon, B. C.; and P. N. Vroom, Vernon, B. C.

INDEX

Thirty-Seventh Annual Meeting of the American Association of Economic Entomologists
Washington, D. C.
December 31, 1924 to January 3, 1925

THIRTY-SEVENTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS, WASHINGTON, D. C., DEC. 31, 1924 TO JAN. 3, 1925

The 37th annual meeting of the American Association of Economic Entomologists will be held at Washington, D. C., December 31, 1924 to January 3, 1925.

The meeting of the Sections of Apiculture and Horticultural Inspection will be held on Wednesday, December 31, prior to the opening session of the general association. The opening business session of the association will be held Thursday morning, January 1, at which time the address of the President will be delivered. Meetings will continue on Friday and Saturday.

Sectional Meetings

The meeting of the Section of Apiculture will be held at 9:30 a. m., Wednesday, December 31, in the Gymnasium, Central High School.

The Section of Horticultural Inspection will meet at 1:30 p. m., Wednesday, December 31, in the Gymnasium, Central High School.

Other Meetings

The annual meeting of the American Association for the Advancement of Science and many of its sections and affiliated societies will be held December 29, 1924 to January 3, 1925.

The Entomological Society of America will open its meeting on Monday, December 29, and continue its sessions through Wednesday, December 31. Dr. L. O. Howard will deliver the public address before this Society, December 31, at 8 p. m.

The Entomologists of Washington are giving the visiting Entomologists a smoker on the evening of December 31. This will take place after the delivery of the public address by Dr. L. O. Howard.

The Extension Entomologists will hold a meeting at the Hotel Harrington, January 1 at 8 p. m. Those interested in extension work should make an especial attempt to attend this meeting.

The Crop Protection Institute will hold its annual business meeting together with discussion of projects on hand, immediately after a

6 o'clock supper on Wednesday, December 31. The place of the meeting will be announced later.

Hotel Headquarters

Hotel headquarters for this Association will be at the Harrington, 11th and E Streets. Rates as follows:

Single room, without bath	$3.00
Double room, without bath	4.00
Single room, with bath	3.50
Double room, with bath	5.00 to 6.00

Railroad Rates

Reduced rates will be secured from some of the railroads. Members should obtain exact information prior to the time of the meeting from their local railroad agent or from Dr. Burton E. Livingston, Permanent Secretary, American Association for the Advancement of Science, Smithsonian Institution, Washington, D. C.

Dinner

The entomologists dinner will be held on Friday evening, January 2, 7 p. m., at Harvey's.

Membership

Applications for membership can be secured from the Secretary or from the Committee on Membership. These should be filled out, properly endorsed, and filed with the Membership Committee on or before December 31. Every application must be accompanied with a fee of $4.00 to cover dues and subscription to the Journal for the year following election.

Exhibits

It is planned to have exhibits consisting of appliances and apparatus used in connection with entomological work, also life history sets, distribution maps and specimens showing damage caused by some of the important economic insects. These exhibits will be displayed near the meeting room.

The Bee Culture Laboratory of the Bureau of Entomology will have open house on Tuesday, December 30, and an invitation is extended to members of the Association and others interested. The various prob-

lems will be explained and mimeographed directions for reaching the Laboratory from headquarters will be furnished at the time of the meeting.

Program

SECTION OF APICULTURE

R. W. Harned, *Chairman* G. M. Bentley, *Secretary*

Wednesday Morning Session, December 31, 9:30
Gymnasium, Central High School

Address of the Chairman, R. W. Harned, Agricultural College, Miss.

Reading of Papers and Discussions

1. The Seventh International Apicultural Congress. (10 min.) E. F. Phillips, Ithaca, N. Y.

2. Notes on Bee Diseases in Connecticut. (10 min.) Philip Garman, New Haven, Conn.

3. Some Things Entomologists Might Easily do to Promote Honey Production. (15 min.) Kenneth Hawkins, Watertown, Wisc.

4. Physiological Factors Affecting the Development of the Brood Diseases of Bees. (10 min.) A. P. Sturtevant, Washington, D. C.

5. The Quantitative and Qualitative Effect of Weather Upon Colony Weight Changes. (10 min.) J. I. Hambleton, Washington, D. C.

6. Brood Rearing Studies. (10 min.) J. H. Merrill, Manhattan, Kans.

7. The Sense of Smell as a Factor Enabling the Bee to Locate Pastures. (5 min.) W. A. Price, LaFayette, Ind.

8. Federal Cooperation in Apiary Inspection Proposed. (10 min.) S. B. Fracker, Madison, Wisc.

9. Brood-rearing Determinations. W. J. Nolen, Washington, D.C.

10. Symposium: Inspection Methods in Different States.

Report of Committees.

Selection of Officers.

Adjournment.

Program

SECTION OF HORTICULTURAL INSPECTION

E. R. Sasscer, *Chairman* W. B. Wood, *Secretary*

Wednesday Afternoon Session, December 31, 1:30
Gymnasium, Central High School

Address by the Chairman, E. R. Sasscer, Washington, D. C.

Reading of Papers and Discussions

1. Recent Work of the Federal Horticultural Board. C. L. Marlatt, Washington, D. C.

2. The Camphor Scale Situation. (12 min.) (Lantern.) H. K. Plank, New Orleans, La.

3. Methods Employed in Enforcing the Gipsy Moth and Browntail Moth Quarantines. (15 min.) D. M. Rogers, Boston, Mass.

4. Port Inspection and a Few of the Problems which are Encountered. (15 min.) L. A. Strong, Washington, D. C.

5. Japanese Beetle Quarantine Operations. (15 min.) C. W. Stockwell, Riverton, N. J.

Reports of Committees.

Selection of Officers.

Adjournment.

Program

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Thursday Morning, January 1, 9:30; Gymnasium,
Central High School

Report of the Secretary.

Report of Subscription Agent, by C. W. Collins, Melrose Highlands, Mass.

Report of the Executive Committee, by President A. F. Burgess.

Report of the Representative to the National Research Council, by George A. Dean, Washington, D. C.

Report of the Committee on Policy, by E. P. Felt, Albany, N. Y.

Report of the Trustees of the Crop Protection Institute, by W. C. O'Kane, Durham, N. H.

Report of Scientific Trustee, Tropical Plant Research Foundation.

Report of the Representatives on the Council of the Union of American Biological Societies, by A. L. Quaintance, Washington, D. C.

Report of the Committee on Nomenclature, by Edith M. Patch, Orono, Maine.

Report of the Committee on Index to Economic Entomology, by E. P. Felt, Albany, N. Y.

Report of the Committee on United States National Museum, by W. E. Hinds, Baton Rouge, La.

Report of Representative Appointed to Attend the Association of Southern States Entomologists, by Herbert Osborn, Columbus, Ohio.

Report of Committee to Standardize methods of Estimating insect abundance and damage, by J. A. Hyslop, Washington, D. C.

Report of Committee Concerning the Purchase of the William Barnes Collection for the U. S. National Museum, by J. J. Davis, Lafayette, Ind.

Appointment of Committees.

Miscellaneous Business.

New Business.

Annual Address of the President, A. F. Burgess, Melrose Highlands, Mass.

1. "Our Association."

Discussion of the Presidential Address.

Program

Thursday Afternoon Session, January 1, 1925, 1:30
Gymnasium, Central High School

READING OF PAPERS

Insects Affecting Cereal, Forage and Field Crops

2. The Chinch Bug and the Weather. (10 min.) (Lantern.) J. A. Hyslop, Washington, D. C.

A correlation of the climatic factors and chinch bug outbreaks from 1870 to 1920.

3. The Hessian Fly Problem in Kansas. (10 min.) J. W. McColloch, Manhattan, Kansas.

4. The Relation of Hessian Fly Damage to Yield. (5 min.) (Lantern.) C. C. Hill, Carlisle, Pa., and H. D. Smith, Carlisle, Pa.

5. The Organized Co-operative Campaign Against Grasshoppers in Wisconsin. (5 min.) (Lantern.) A. A. Granovsky, Madison, Wisc.

6. The Arsenical Poisoning of Live Stock. (10 min.) Geo. I. Reeves, Salt Lake City, Utah.

Toleration of animals for arsenic, clinical diagnosis, post-mortem diagnosis; Dr. Gardner's experiments; relation to spraying for the alfalfa weevil.

7. *Phthorimaea operculella* in the Eastern States. (10 min.) (Lantern.) Herbert Spencer and W. O. Strong, Norfolk, Va.

A discussion of the recent outbreak of the insect, and its relation to potato and tobacco growing.

8. Economic Wireworms of the Pacific Northwest (Elateridae). (10 min.) M. C. Lane, Toppenish, Wash.

Paper will be a brief summary of Life History work and control of several Economic wireworms of Pacific Northwest.

9. The Status of the European Corn Borer in Ontario (1924). (8 min.) L. S. McLaine and H. G. Crawford, Ottawa, Canada.

A brief review of the European Corn Borer situation in Ontario, indicating the increase in intensity of infestation in certain districts and spread during 1924.

10. Status of the European Corn Borer in the United States in 1924. (10 min.) (Lantern.) D. J. Caffrey, Arlington, Mass.

General summary of spread and results of investigations on the control, habits, distribution and parasites of the corn borer. Includes European observations during 1924.

11. On Certain Behavior of the European Corn Borer. (5 min.) L. L. Huber, Wooster, Ohio.

Insects Affecting Truck Crops

12. A New and Effective Control for the Onion Maggot. (10 min.) (Lantern.) W. P. Flint and C. C. Compton, Urbana, Ill.

Results of experimental work in the control of the onion maggot extending over a period of six years conducted in the large onion growing sections in Cook County, Illinois.

13. Cull Onions as a Trap Crop for the Onion Maggot. (5 min.) J. E. Dudley, Jr., Madison, Wisc.

Results of experiments in the use of cull onions planted early in the spring to attract adults of the onion maggot, and yields.

14. The Pea Aphis (*Illinoia pisi*) with Special Reference to Alfalfa. (10 min.) R. C. Smith and E. W. Davis, Manhattan, Kansas.

An account of recent outbreaks in Kansas and a summary of field and laboratory observations on its habits and life history.

15. Natural Enemies of the Pea Aphid (*Illinoia pisi* Kalt.); their Abundance and Distribution in Wisconsin. (5 min.) Chas. L. Fluke, Jr., Madison, Wisc.

The pea aphid predators are many and varied. Studies this past year at Columbus, Wis. give some idea of the abundance of certain groups and the relative importance of others. Numerous species not heretofore mentioned are included in the list.

16. Climate as Related to Mexican Bean Beetle Distribution. (10 min.) (Lantern.) J. E. Graf, Washington, D. C.

17. Recent Developments of Mexican Bean Beetle Investigations. (10 min.) (Lantern.) Neale F. Howard, Birmingham, Ala.

Brief review of spread, biology and control of Mexican bean beetle.

18. Non-arsenicals for Chewing Insects. (10 min.) S. Marcovitch, Knoxville, Tenn.

19. Percentage of Curly Leaf Infection in Beet Leafhopper (*Eutettix tenella* Baker) and Winter Host Plants under Field Conditions. (5 min.) Henry H. Severin, Berkeley, Calif.

20. The Control of the Spinach Aphis, *Myzus persicae* Sulz., Infesting Cauliflower Seed Beds on Long Island, by Tobacco Dust Mixtures. (10 min.) (Lantern.) H. C. Huckett, Riverhead, Long Island, N. Y.

21. Celery Leaf Tyer in California. (10 min.) R. E. Campbell, Alhambra, Calif.

Insects Affecting Greenhouse Crops

22. Further Data on the use of Calcium Cyanide as a Greenhouse Fumigant. (5 min.) C. A. Weigel, Washington, D. C.

Observations on the behavior of calcium cyanide with reference to the length of exposure. Results are given of further tests with this material when used under commercial growing conditions in greenhouses.

23. Notes on the Life History of the Lesser Bulb Fly, *Eumerus strigatus* Fallen. (5 min.) (Miss) B. M. Broadbent, Washington, D. C.

Brief account of life history under cage conditions in greenhouse including recent data on feeding habits of larva and fly, on eggs and place of oviposition, and on duration of different stages.

24. *Eurytoma (Isosoma) orchidearum* Westwood, The Orchid or Cattleya Fly. (8 min.) (Lantern.) C. F. Doucette, Willow Grove, Pa.

Economic importance, and present methods of control.

Program

Friday Morning Session, January 2, 1925, 9:30
Gymnasium, Central High School

READING OF PAPERS

25. Observations on Biological Control Work in California. (10 min.) (Lantern.) Harry S. Smith, Riverside, Calif.

Data with reference to the commercial aspects of control of citrus pests by use of natural enemies.

26. The Dissemination of Insects by Air Currents. (10 min.) E. P. Felt, Albany, N. Y.

A summation of the evidence relative to insects being carried by air currents.

27. Stability in Scientific Names. (5 min.) R. W. Doane, Stanford University, Calif.

28. Entomologists Entering Commercial Fields. (5 min.) J. G. Sanders, Philadelphia, Pa.

A hopeful indication that the standards of commercial companies are improving with their realization that trained men are necessary to their success.

29. Foreign Travel and Entomologists Met while Searching for Enemies of the Gipsy Moth and the Brown-tail Moth. (10 min.) S. S. Crossman, Melrose Highlands, Mass.

A brief outline of the area covered and foreign entomologists visited during recent travels in Europe and northern Africa investigating Gipsy Moth and Brown-tail Moth infestations with a view to obtaining insect parasites and predators for introduction into the United States.

30. The Influence of Temperature and Humidity upon the Life Cycle of *Myzus houghtonensis* Troop. (5 min.) (Lantern.) D. M. DeLong and A. A. Mathewson, Columbus, Ohio.

A study of the life cycle of *Myzus houghtonensis* with special reference to the effect of temperature and humidity upon the variation in the number of days required for various season generations.

31. Extension Methods and Results in Kansas Entomology. (10 min.) E. G. Kelly, Manhattan, Kansas.

Presents outline of procedure in putting over effective methods of controlling the Hessian fly, chinch bug, potato bug and grasshoppers, giving value in dollars.

INSECTS AFFECTING FRUIT

32. A Bait which Attracts the Oriental Fruit Moth (*Laspeyresia molesta* Busck.) (10 min.) (Lantern.) Alvah Peterson, New Brunswick, N. J.

A preliminary report on two years' experience with baits which attract the oriental fruit moth. Also some notes on the habits and life history of *Laspeyresia molesta* Busck.

33. Additional Notes on the Life History and Behavior of the Oriental Fruit Moth (*Laspeyresia molesta* Busck.) in Pennsylvania. (5 min.) T. L. Guyton, Harrisburg, Pa.

34. Orchard Control Work of 1924 Against the Oriental Peach Moth in South Jersey. (10 min.) (Lantern.) L. A. Stearns, New Brunswick, N. J.

This paper is a record of observations and a report of results of experimental work in cultivation, spraying and dusting conducted on the plots at the Seabrook Farm in South Jersey, which were visited by the members of the American Association of Economic Entomologists at their field meeting on Aug. 1, 1924.

35. *Laspeyresia molesta* Busck. as a Quince Pest. (5 min.) (Lantern.) E. N. Cory, College Park, Md.

Records of unusual losses, the overwintering habits and the treatment of containers.

36. Life History of the Pecan Nut Case-bearer (*Acrobasis caryivorella*). (10 min.) (Lantern.) S. W. Bilsing, College Station, Tex.

A brief survey of the life history of the pecan nut case-bearer extending over a period of 6 years.

37. A Small Contribution to Knowledge of Arsenical Requirements for Control of Codling Moth. (10 min.) T. J. Headlee, New Brunswick, N. J.

Under conditions of extreme codling moth abundance and the presence of two broods, the field control exerted by arsenicals varies within limits as the amount of arsenical used and as the continuity with which the coating is maintained.

38. The Efficiency of Dust and Spray Mixtures in Controlling the Rosy Aphis. (5 min.) P. J. Parrott and Hugh Glasgow, Geneva, N. Y.

Reports the results of a series of experiments with several oil emulsions and various dust and spray mixtures to determine their value in controlling the rosy aphis. The merits of delayed dormant, early and late pink, and calyx applications are also considered.

39. The Natural Enemies of the Citrus Aphid (*Aphis spiraecola* Patch) in Florida. (10 min.) F. R. Cole, Orlando, Fla.

Statement of importance of pest and control by insect enemies (of three orders), all predators.

40. The Citrus Aphid Outlook. (10 min.) (Lantern.) A. C. Baker, Washington, D. C.

In the spring of 1924 there occurred in Florida an epidemic of an aphid on citrus. Transfer tests have proved the species concerned to be *Aphis spiraecola* Patch. A correlation between the growth of the epidemic and climatic conditions has indicated that the epidemic may in great part be laid to these conditions.

41. Notes on Applied Entomology in Spain with Special Reference to the Mediterranean Fruit Fly (*Ceratitis capitata* Wied.). (10 min.) (Lantern.) M. D. Leonard, Ridgewood, N. J.

42. The Value of the Dry Substitutes for Liquid Lime Sulphur as a Control for San Jose Scale. (10 min.) (Lantern.) J. J. Culver, Vienna, Va.

Presents results of three years' work against San Jose scale.

43. San Jose Scale Control with Lubricating Oil Emulsion on Peach Trees in the South. (10 min.) C. H. Alden, Fort Valley, Ga.

Program

Friday Afternoon Session, January 2, 1925, 1:30
Gymnasium, Central High School

READING OF PAPERS

INSECTICIDES

44. A Method of Computing the Effectiveness of an Insecticide. (10 min.) (Lantern.) W. S. Abbott, Vienna, Va.

A formula is proposed for obtaining a figure called "percent control" by means of which a series of results based on different checks may be compared.

45. An Investigation of Sulfur as an Insecticide. (7 min.) Albert Hartzell, Yonkers, N. Y. and F. H. Lathrop.

A preliminary study of the toxicity of sulfur with special reference to the solvent action of lime sulfur on San Jose scale.

46. Fish Oil—An Efficient Adhesive in Arsenate of Lead Sprays, and Results with Other Substances Used. (10 min.) (Lantern.) C. E. Hood, Melrose Highlands, Mass.

A brief discussion of the different substances used, and the comparison of each as to adhesive qualities. These experiments were conducted at Melrose Highlands and Saugus, Mass., and Somerville, N. J.

47. The Dipyridyls as Contact Insecticides. (10 min.) (Lantern.) C. H. Richardson, Washington, D. C.

48. Electric Charges on Insecticide Particles. (10 min.) William Moore, New York, N. Y.

Difference between static electric charges imparted by friction and charges due to absorbed ions.

49. Miscible Oils and Oil Emulsions. (10 min.) J. G. Sanders, Philadelphia, Pa.

Discussion of emulsions and oils for emulsions and some of the pitfalls encountered in making and using oil emulsions.

50. Quantitative Studies on the Toxicology of Arsenical Insecticides. (10 min.) F. L. Campbell, Forest Hills, Boston, Mass.

By feeding individual caterpillars known quantities of arsenical solutions, quantitative relationships between dose and survival time were studied.

51. A Preliminary Report on the Preparation of Insecticide Emulsions with a Colloidal Clay. (5 min.) L. L. English, Ames, Iowa.

52. Observations on Insects Developing Immunity to Insecticides. (10 min.) R. S. Woglum, Pasadena, Calif.

Certain scale insects of citrus trees in California require heavier dosages of HCN for control than formerly. The areas of resistant scale are being extended.

53. The Use of Fatty Acids as a Contact Insecticide. (10 min.) E. H. Siegler and C. H. Popenoe, Washington, D. C.

An investigation of the aliphatic fatty acids has shown that certain members of the saturated series possess promising insecticidal properties as contact sprays. The studies have indicated that the toxicity of soaps when used as contact sprays is due to the release of the acid components through hydrolytic dissociation.

54. "Gassing Ants"—Experiments in Killing the "Hormiguilla," *Myrmelachista ambigua vamulorum* Wheeler, of Porto Rican Coffee Groves with Cyanide. (5 min.) George N. Wolcott, Barneveld, N. Y.

55. The Distribution of an Insecticide Made Visible. (10 min.) (Lantern.) A. C. Morgan and R. G. Newborne, Clarksville, Tenn.

A mixture of phenolphthalein and arsenate of lead was dusted on tobacco. A print of the leaves was taken on filter paper impregnated with an aqueous solution of sodium hydrate. The prints were immediately dried in an oven to prevent spreading of the indicator and were then paraffined for preservation.

56. A Coloremetric Method for Showing the Distribution and Amount of Lead Arsenate upon Sprayed and Dusted Surfaces. (10 min.) (Lantern.) C. C. Hamilton and C. M. Smith, College Park, Md.

Insects Affecting Stored Products

57. Present Status of the Use of Electricity in Control of Stored Product Insects. (10 min.) (Lantern.) E. A. Back and R. T. Cotton, Washington, D. C.

Brief status concerning use of electricity.

58. Control of the Saw-toothed Grain Beetle in Raisins: A Preliminary Report. (10 min.) (Lantern.) J. C. Hamlin and Curtis Benton, Fresno, Calif.

Summarizes experiments in connection with (1) reducing existing severe infestations and (2) preventing infestation of incoming raisins in the plants.

59. A Newly Recommended Fumigant; Ethyl Acetate in Combination with Carbon Tetrachloride. (10 min.) E. A. Back and R. T. Cotton, Washington, D. C.

The effectiveness of Ethyl Acetate—Carbon Tetrachloride mixture as a fumigant for stored product insects under certain conditions.

60. The Causes of Outbreaks of the Angoumois Grain Moth. (10 min.) Perez Simmons and G. W. Ellington, Silver Spring, Md.

The correlations between Angoumois grain moth abundance and the thermal environment in a selected area (the region around Philadelphia) during the past 28 years indicate the probability that the principal factor influencing the occurrence of moth outbreaks there is the temperature from June to October. Time of harvest nd winter temperatures also appear to be of importance.

61. Relative Abundance and Control of Grain Moth (*Sitotroga cerealella*) in Pennsylvania in 1924. (3 min.) (Lantern.) H. B. Kirk, Harrisburg, Pa.

Field studies showing possible means of control by farm practices.

62. A Practical Control of the Common Bean Weevil, *Bruchus obtectus* Say. (10 min.) A. O. Larson and C. K. Fisher, Alhambra, Calif.

A progress report dealing with the field control work which has been carried on in California.

Program

Saturday Morning Session, January 3, 1925, 9:30
Gymnasium, Central High School

READING OF PAPERS

Insects Affecting Man and Animals

63. Controlling Bedbugs in Steam-heated Rooms. (10 min.) (Lantern.) R. W. Harned and H. W. Allen, A. &.M. College, Miss.

64. Repellents and Larvicides for the Screw worm and other Flies—Report of Progress. (10 min.) F. C. Bishopp, R. C. Roark, D. C. Parman and E. W. Laake, Dallas, Texas.

Treats of recent work on the chemotropic responses of the screw worm and other flies and discusses investigations of the more promising repellents against them.

65. The Occurrence of Cuterebrid Larvae in Dogs and Cats, and the Possible Modes of Infestation. (8 min.) M. C. Hall, Washington, D. C.

This paper summarizes the records to date, adds a number of new ones, discusses the possible modes of infection, and points out the economic interest of the subject, the evidence showing that these cases are fairly common.

66. Intestinal Myasis and The Common House-Fly (*Musca domestica* L.). (2 min.) T. H. Frison, Urbana, Ill.

67. Tests of Internal Medication for External Parasites of Fowls. (10 min.) D. C. Parman, Uvalde, Texas.

Insects Affecting Forest and Shade Trees

68. Two Dangerous Defoliators of Jack Pine. (10 min.) (Lantern.) S. A. Graham, St. Paul, Minn.

This paper describes an outbreak of the jack pine sawfly and the jack pine tip moth now in progress in the Lake States.

69. Some Results of Defoliation of Oak Trees. (10 min.) (Lantern.) C. W. Minott and I. T. Guild, Melrose Highlands, Mass.

70. Methods of Control for two Shade-tree Pests. (5 min.) Glenn W. Herrick, Ithaca, N. Y.

The maple bladder-gall (*Phyllocoptes quadripes*) is readily susceptible to applications of lime-sulphur while the spruce-gall aphid (*Chermes abietis*) is readily susceptible to applications of lime-sulphur and of miscible oils. Experimental work of the past 3 years demonstrate the ease with which these pests may be controlled. A full discussion of the biology and control of the latter pest is in preparation.

71. A Preliminary Report on the Use of Calcium Cyanide for the Mound Building Ant, *Formica exsectoides*. (10 min.) (Lantern.) J. A. Manter, Storrs, Conn..

A report of the results obtained by using calcium cyanide for control of the mound building ant in forest plantations.

72. Barkbeetle Epidemics and Rainfall Deficiency. (10 min.) F. C. Craighead, Washington, D. C.

Japanese Beetle

73. The Status of the Japanese Beetle in 1924. (5 min.) Loren B. Smith, Riverton, N. J.

A resume of results secured in control and prevention of spread.

74. A Preliminary Report on the Parasites of *Popillia japonica*. (10 min.) (Lantern.) J. L. King and H. C. Hallock, Riverton, N. J.

This paper deals with the establishment and rearing of parasites of *Popillia japonica*.

75. Three Years Observation on the Biology of *Popillia japonica.* (10 min.) (Lantern.) C. A. Thomas, Riverton, N. J.

A comparison of the important phases in the life-cycle of Popillia for the years 1922–1924 inclusive.

76. The Fumigation of Balled Nursery Stock. (10 min.)(Lantern.) B. R. Leach and W. E. Fleming, Riverton, N. J.

The soil-ball is fumigated with carbon disulphide vapor, the foliage being submerged in water during the operation by means of a special apparatus.

77. Coated Arsenate of Lead and the Physical Chemistry of the Coating Process. (10 min.) E. R. VanLeeuwen and Dr. P. A. van der-Meulen, Riverton, N. J.

This paper deals with the coating of lead arsenate with a metallic soap and its use against the Japanese beetle. When lead oleate is precipitated under proper conditions it forms an intimate mixture consisting of globules of lead oleate with uncoated particles of arsenate of lead. After drying the lead oleate spreads upon the surface of the arsenate of lead powder and upon the leaf and produces a coated material which adheres very firmly to the leaf surface.

78. Geraniol, a Primary Attractent of the Japanese Beetle. (10 min.) (Lantern.) Loren B. Smith and E. A. Richmond, Riverton, N. J.

The results of three years' study of essential oils and their constituents with regard to their effect upon the activities of the Japanese Beetle.

79. Chemicals Found Attractive to Insects. (10 min.) N. E. McIndoo, Washington, D. C.

FINAL BUSINESS

Report of Committee on Resolutions.
Report of Committee on Membership.
Reports of other committees.
Nomination of JOURNAL officers by advisory committee.
Report of Committee on Nominations.
Election of Officers.
Miscellaneous business.
Fixing the time and place of next meeting.
Final adjournment.

A. F. BURGESS, *President*,
Melrose Highlands, Mass.

C. W. COLLINS, *Secretary*,
Melrose Highlands, Mass.